AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

The American Railroad Journal, founded in 1832, was consolidated with Van Nostrand's Engineering Magazine, 1887, forming the Railroad and Engineering Journal, the name of which was changed to the American Engineer and Railroad Journal, January, 1893.

PUBLISHED MONTHLY AT No. 47 CEDAR STREET, NEW YORK.

M. N. FORNEY, . . . Editor and Proprietor.
FRANK J. FRENCH, ... Business Manager.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid............$3 00
Subscription, per annum, Foreign Countries........... 3 50
Single Copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

The paper may be obtained and subscriptions for it sent to the following agencies:
Chicago, News Stand, Grand Pacific Hotel.
London, England, Sampson Low, Marston & Co., Limited, St. Dunstan's House, Fetter Lane, E. C.
Berlin, Germany, W. H. Kühl, 73 Jäger St.

NEW YORK, DECEMBER, 1894.

1895.

On the approach of a new year an editor always feels that he ought to have something to say to his readers and patrons which will be indicative of his plans and purposes for the future. If he has had any novel enterprises on the stocks he then launches them, and breaks his bottle of wine with as much *éclat* as the prospects and circumstances will permit, and tells his readers with more or less confidence, according to the degree of prosperity in which he is basking or the adversity which he is enduring, "where he is at." But both people and papers in their youthful years undertake more new enterprises and make more promises than those who are gray-headed do, and who have kept up a more or less steady gait for half a century or more, and have entered, perhaps, on the last decade of three score and ten. With 1895 the *American Railroad Journal*, with which the AMERICAN ENGINEER is now incorporated, enters upon the sixty-third year of its life. Its first number appeared January 1, 1832, and since then, with a few temporary gaps, it has had a continuous existence. 1895 will be the ninth year that it has been conducted under its present management. It has maintained its character and position during all that period, and emerges from the general financial and business depression—which is now happily passing away—with those features which have heretofore made it attractive more fully developed than ever. It has been the aim of its editors to bring each number nearer abreast with the advancing march of engineering and mechanical science and art, and it is more carefully edited, is better illustrated now than it has ever been, and its size and the quality of its typography are fully maintained. During the year 1895 no backward step will be taken; but in each successive month whatever occurs which, in the opinion of its editors, will interest mechanical engineers most will be reported, published, illustrated, or commented on. Each number of the paper will contain, as heretofore, not less than 48 pages of reading matter. Its special features, together with its illustrations of various engineering works, new machinery, etc., editorial comment on current engineering topics, original contributions and articles written especially for its pages, selected matter from foreign and domestic sources, book notices and reviews carefully written, personal items, condensed paragraphs of information collected from everywhere, engineering and mechanical notes and news, descriptions of newly patented inventions, and other information within reach of its editors, make it one of the most attractive journals now published for engineers, manufacturers, mechanics, draftsmen, inventors and students.

To all who are engaged in producing anything which pertains to mechanical engineering, railroad operations, or marine construction, it is an influential medium for making their occupation and their products known. All who contemplate making an effort to extend their business during the coming year are solicited to give to the AMERICAN ENGINEER AND RAILROAD JOURNAL at least a share of their patronage, which it will be the aim of the editors of the paper to present in such a form as will do the advertisers the most good. Rates will be given and position assigned on application, and, if desired, forms of advertising will be prepared and engravings made adapted to illustrate the business which is to be extended. For any further information address

M. N. FORNEY, *Editor and Proprietor*,
No. 47 Cedar Street, New York.

EDITORIAL NOTES.

THE *St. Louis*, a brief description of which was published in our last issue, has been launched amid apparently great rejoicing at the Cramps' Yard. It is indeed a cause of congratulation that the American Line will soon become an American line in fact as well as in name, and the special act of Congress which admitted the *Paris* and *New York* to American registry is thoroughly warranted by these new additions to vessels flying the flag of the United States. That the speed of the *St. Louis* will be well up to the requirements of the contract there is no reason to doubt, for the Cramps are not in the habit of building vessels that prove to be laggards, as is evidenced by the premiums won by the *Columbia* and *Minneapolis*.

THE Canadian Society of Civil Engineers has taken a step in the direction of securing compensation for professional service in a line with the practice abroad. At a recent meeting a resolution was adopted in which the practice of submitting plans and estimates without compensation to small municipalities that seek professional advice gratuitously was condemned. That the practice has its hardships for the consulting engineer there can be no doubt, but the fact that large establishments, with a corps of engineers and draftsmen at their disposal, are ready and willing to submit plans and estimates free of cost in the hope of procuring the subsequent contract, forces the little fellows to follow the same line of conduct or be crowded out

of existence. It is an unfortunate condition of affairs, and one that is undoubtedly frequently taken advantage of by unscrupulous men in order to secure professional advice free of charge; but it is difficult to see how the action of the society can change the state of affairs that they so deplore.

HOW CAN THE FUEL CONSUMPTION OF LOCOMOTIVES BE DIMINISHED?

In the American Engineer for July, page 295, of the current volume, there was published a report, which was submitted to the last convention of the Master Mechanics' Association, of the comparative performance of Mr. Webb's London & Northwestern compound locomotive *Greater Britain*, and two engines—one of them the celebrated No. 999—of the New York Central Railroad. In the September number, page 423, we published another report of a test of an engine of the same class on the same road. In the last number, page 517, a report of a remarkable test of an eight-coupled compound, and an exactly similar simple freight locomotive on the London & Northwestern Railroad, was reprinted from the *Railway Engineer*. The *Engineer* of November 2 contains engravings of two of the most recent examples of English passenger locomotives built by Mr. Dean, the Locomotive Superintendent of the Great Western Railway. One of these is what in England is called a "single" engine—that is, it has only a single pair of driving-wheels; the other is a "coupled" machine, and has two pairs of drivers. Both have leading trucks and inside cylinders. With the description of these machines a somewhat meager report is given of their performance. These five reports, then, it is thought, represent the best performance of modern locomotives, and the principal figures contained therein have been summarized in the appended table. It should be said, however, that the performance of Mr. Dean's engines, which is reported, is not the result of a special test, but is the average performance in daily use, extending over a period of two years. Neither are the figures representing the weight of train accurate, but are "estimated," so that doubtless Mr. Dean could make a somewhat better showing if he subjected his engines to special tests, as the other engines were. It should also be pointed out that only the performance of his coupled engines is reported. The *Engineer* says that the Great Western Railway is nearly level, and in that respect resembles the New York Central.

The table is interesting, as it enables us to compare the performance of some of the best types of simple and compound locomotives of the most recent design, and also what are perhaps the best and most powerful types of English and American express locomotives. While the table enables us to compare the performance of Mr. Webb's compound passenger engine with one of our best simple machines, we have no data for making a comparison of the fuel consumption of American compound engines. Mr. Webb's figures enable us to see what the relative fuel consumption of his compound freight engines was in comparison with one of his simple engines of almost exactly the same type; but our table does not give any similar data concerning the fuel consumption of our best American simple or compound freight locomotives, although doubtless such figures would be obtainable. It must be said, though, that the advocates of compound locomotives in this country are a little chary about giving full reports of their fuel consumption.

Locomotive	Kind of Locomotive.	Weight of Locomotive and Tender in Working Order.	Weight of Cars in Train and Contents.	Ratio of Weight of Locomotive and Tender to Weight of Cars and Contents.	Total Distance Traveled by Train.	Average Speed, Actual Running Time.	Consumption of Coal per Mile, Including Raising Steam.	Consumption of Coal per Mile per Ton of Cars and Contents, Exclusive of Locomotive and Tender, Including Raising Steam.
		T.* Cwt.	T.* Cwt.			Miles per Hour.		
"Greater Britain," London and North Western Railway	Webb's Compound Four-Coupled Passenger	77 2	160 8	1 to 2 08	3,588 mi.	47.66	31.07 lbs.	2.979 oz.
Number 888, New York Central Railroad	Buchanan's Simple Four-Coupled Passenger	89 6	162 14	1 to 1.82	1,776 "	52.24	34.69 "	3.300 "
" " " " " "	Buchanan's Simple Four-Coupled Passenger	89 6	180 12	1 to 2.02	3,848 "	51.13	35 "	2.960 "
Number 999, New York Central Railroad	Buchanan's Simple Four-Coupled Passenger	91 0	279 0	1 to 3.06	1,287 "	45.42	39.21 "	2.180 "
" " " " " "	Buchanan's Simple Four-Coupled Passenger	91 0	186 10	1 to 2.05	3,848 "	50·50	31.04 "	2.662 "
" " " " " "	Buchanan's Simple Four-Coupled Passenger	91 0	......	....	296 "	50.50	12.87 "	2.26† "
London and North Western Railway No. 2524	Webb's Simple Eight-Coupled Freight	76 2	698 5	1 to 9.17	96 "	17.74	71.49 "	1.65 "
" " " " " " 50	Webb's Compound Eight-Coupled Freight	75 17	691 15	1 to 9.12	96 "	17.74	57.3 "	1.325 "
Achilles Class, Great Western Railway of England	Dean's Simple "Single" Passenger	81 10	200	1 to 1.227	....	51.77	31.0 "	2.48 "
Achilles Class, Great Western Railway of England	Dean's Simple "Single" Passenger	81 10	200	1 to 1.227	....	51.34	33.0 "	2.64 "

* 2,240 lbs. † Per ton of weight of engine and tender.

It was remarkable that the report made to the Convention of the Master Mechanics' Association attracted so little attention. The members of the Association who heard it did not seem to fully comprehend the significance of the figures it contained. At the time that Mr. Webb made the test of his *Greater Britain* and published the report of it, those who studied the report saw at once that it indicated a most remarkable economy of fuel consumption.

In a carefully prepared table, which was published in the American Engineer of December, 1891, page 530, it was shown that with passenger trains the average consumption of coal on a dozen different roads, which keep careful accounts, was a little over ½ lb. (.515 lb. = 8¼ oz.) per ton per mile of cars and their contents, exclusive of engine and tender. This, it must be remembered, was at the average rate of speed of such trains, which is very slow. On the Philadelphia, Wilmington & Baltimore Line it was shown, in a table published in February, 1892, page 54, that the allowance of coal to engineers for running their through passenger trains

from Philadelphia to Washington was .419 lb. = 6.7 oz., while on the Fort Wayne Road for through passenger trains it was from .30 to .36 lb. = 4.8 to 5.76 oz. This was at speeds averaging probably less than 40 miles per hour. The fuel consumptions on passenger trains per ton per mile are given in our table herewith, in the order of their magnitude, 3.3, 2.979, 2.960, 2.662, 2.64, 2.48, 2.26, 2.180 oz., at average speeds varying from 45.42 to 52.34 miles per hour. It will be seen that the difference between these figures and those quoted above is enormously great. Roughly stated in the best performance of locomotives the fuel consumption is *only half* that of the average performance on well-managed railroads. It is not only in passenger service either in which this difference exists. The average consumption of coal with freight trains on the dozen roads referred to was .215 lb. = 3.44 oz. per ton per mile. The average allowance of coal for freight trains on the Philadelphia, Wilmington & Baltimore Railroad (see the AMERICAN ENGINEER for February, 1892, page 54) was .253 lb. = 4.048 oz., while Mr. Webb's simple engine burned only 1.65 and his compound engine 1.325 oz. per ton of cars and contents per mile; the average actual consumption being again over twice as much as it was in the test referred to.

Of course persons who are familiar with the conditions which prevail when such tests are made understand the reason for the great difference which has been pointed out. Doubtless in all the tests—excepting, perhaps, those on the Great Western Railway of England, the data of which are taken from the ordinary work extending over a considerable period —the engines were first in as nearly a perfect condition as it was possible to make them; next, the fuel was probably the best that could be obtained; and third, the utmost care and the most skillful and careful men were employed to produce the results which are reported. He would be a very sanguine person who would for a moment indulge in the dream that engines can be maintained in conditions of maximum efficiency, that the best and most intelligent and faithful service can always be obtained from the men who run them, or that fuel even approximating in quality to the best is always obtainable. Nevertheless, the results of the tests of Mr. Webb's, Mr. Buchanan's and Mr. Dean's locomotives show what degree of economy is attainable with existing locomotives. The data quoted shows that there is abundant room for improvement from better maintenance, better management and the use of good fuel, and that it cannot be assumed that modern locomotives have reached a maximum degree of efficiency or economy.

The attention, too, of locomotive superintendents is called to the remarkable figures in our table. Who can match them? and if the degree of economy attained by these engineers cannot be equaled on other roads, it would be a very pertinent inquiry to ask, Why not?

A noteworthy fact, too, is that both Mr. Buchanan's and Mr. Dean's simple engines were more economical than Mr. Webb's compound passenger locomotive, although the relative weight of train to that of the engine and tender was not quite so great with the simple machine as it was with the compound, but the speeds were higher. It would be opportune to challenge the advocates of compound locomotives in this country to give us some similar data with reference to their performance corresponding to that which is given in our table. In that it appears that trains more than twice as heavy as the engine and tender are hauled at speeds of over 50 miles per hour with a consumption of coal of a little over 2¼ oz. per ton of cars and contents per mile. If any compound engine in this country can beat this, it is desirable to know it. Who will give us a test similar to that which Mr. Webb has made, of one of our heavy freight engines? His simple engine burned a little over 1⅝ oz. per ton of train per mile, while his compound consumed only 1¼ oz. Who in this country can match this either with simple or compound engines?

NEW PUBLICATIONS.

INDEX TO TECHNICAL JOURNALS.

The *Engineering Magazine* has added an annex to its different departments in which it reports the progress of the science and art to which it is devoted. These departments are Architecture and Building; Civil Engineering; Domestic Engineering; Electricity; Industrial Sociology; Marine Engineering; Mechanical Engineering; Mining and Metallurgy; Municipal Engineering; Railroading; Street Railways, and Scientific Miscellany. At the end of each of these departments an index to leading articles which have appeared in different publications during the preceding month is given, and which will be found useful by all who are interested in the subjects to which these articles relate. It is to be regretted, though, that the various efforts which are now being made to index current technical literature cannot be combined in some way. An index to the indexes will soon be needed.

THROUGH LOCOMOTIVE WORKS. *Being Advice to Young Mechanical Engineers.* By Randal W. McDonnell. Dublin: William McGee; London: Simpkin, Marshall, Hamilton, Kent & Co. 61 pp., 5 × 7½ in.

This little book, which can be read in a half hour or less, will carry those who have been through the shops back to the recollection of their early days, when it seemed to some of us that we had a hard road to travel. The advice and experience of the writer are interesting, but will not be of very great value to any who have to go over the road which he attempts to blaze. Unfortunately, we all find out the value of good advice when it is too late. In the present instance there is not much room for this bitter reflection, because the author does not give much advice, but contents himself by describing very briefly what his own experience in the shop was. It will give a reader an idea of what an apprentice in an English or Irish locomotive shop must encounter. At the present day, when government by trades unions and walking delegates is impending, there seems to be a dearth of the kind of literature which was intended to be a guide to apprentices. There is a superabundance of technical literature—such as it is—but it seems as though it would be wholesome to impress upon apprentices and mechanics at times the obligation of obeying the ten commandments, faithfulness to employers, and directions to those who have been without early advantages how to improve their minds. In none of these directions has the book before us much value.

CATALOGUE OF THE EXHIBIT OF THE PENNSYLVANIA RAILROAD COMPANY AT THE WORLD'S COLUMBIAN EXPOSITION, under the Direction of Theodore N. Ely, Chief of Motive Power, and J. Elfreth Watkins, Special Agent in Charge of Exhibit. The Pennsylvania Railroad Company, Philadelphia. About 180 pp., 5¾ × 11¼ in.

Mr. Ely's name is always a synonym of good taste, no matter whether it is attached to the design of a car, the furnishing of a room, or the typography and illustrations of a book. The volume before us is a confirmation of this observation. It is admirably printed, illustrated and arranged. The paper is of a heavy "coated" quality, which, besides having positive merits, has also the negative one of not smelling bad, which fault is often a cause of offense in that material.

In a preface it is said that "It is the purpose of the Exhibit not only to perpetuate the early history of the Pennsylvania Railroad Company and of the lines merged into or associated in interest with it, but also to place permanently upon record the results that have attended the efforts of the management to introduce those advanced methods in the art of transportation which have culminated in such a high degree of efficiency as to entitle the Pennsylvania to be known as 'the standard railroad of America.'"

In a circular enclosed with the volume it is also said that the exhibit described has been sent to the Field Columbian Museum, of Chicago, by the Pennsylvania Railroad Company, and is now installed in the museum building in Jackson Park, Chicago.

The book is elaborately illustrated, first with views of the beautiful building in which the Exhibit was housed during the Exposition, a map of the grounds, and some of the outdoor exhibits. It is to be regretted, though, that the engravings of the building were made on so small a scale. They are printed on a large page, which would have admitted of the illustrations being made of nearly twice the area they now are, in which form they would have been much more effective than they appear.

A review of a catalogue of this kind is almost a hopeless task. It is like reviewing a dictionary. The views referred to are followed by an excellent half-tone engraving of the celebrated *John Bull*, built for the Camden & Amboy Railroad, and its train, which has been illustrated so often. This is as large as the page will admit, and is excellent in every way. This is followed by some views of the cars for the large guns which were exhibited. Then there are drawings or views of cars, of models of an old Conestoga wagon and stage coach, canal boats, old locomotives, tug and ferry-boats, signals, bridges, and then a long list, which fills about one-quarter or a third of the book, of "relics" in frames and cases, on which we might descant to the extent of many pages. A series of excellent views of modern equipment locomotives and cars is also a feature. Again we wonder that the scale of these was not increased, for which there was abundant room. The book ends with a series of *fac-simile* engravings of old posters, way bills, tickets, etc.

There is no index though, which is the only serious fault we can find with the publication.

CENTRIFUGAL PUMPS, *an Essay on their Construction and Operation, and some Account of the Origin and Development in this and other Countries*. By John Richards. San Francisco: The Industrial Publishing Company. 68 pp., 6¼ × 9¼ in.; $1.00.

Mr. Richards's book consists of the articles which were republished from *Industries*—the paper of which he is the editor—in recent numbers of the AMERICAN ENGINEER. In these articles the author says he has dealt with the subject empirically, and in many cases has felt called upon to controvert assumed data. He says, further, that the principles of centrifugal pumps defy the mathematician, and for this reason there is little literature which has aided the makers of such pumps to any considerable extent. The author continues in his introduction to say that "formulæ, such as exist, are ignored by the practical pump-maker, who soon learns, to his cost sometimes, that computations will not supply proportions or define the working conditions required, and that he must proceed tentatively and tediously to ascertain the best forms of construction for particular uses, and for the head and pressure in each case." This latter quotation will give the keynote of the articles which form the book before us, the title of which should have been "Practical Notes on Centrifugal Pumps." It can hardly be regarded as a treatise on the subject, for the reason that it is not sufficiently comprehensive. Its general defect is that the author has assumed that his readers knew much more about centrifugal pumps than they do. It is always safe to assume, in beginning a book, that the persons who will read it know nothing about the subject of which it treats; and it is a fact that no matter how well acquainted with a subject a person is, he nearly always enjoys and, to a greater or lesser extent, is profited by reading clear, elementary expositions of it. The interest and profitableness of Mr. Richards's essay would have been much increased to many of his readers who, like his reviewer, are not experts in hydraulic engineering, if he had explained a little more fully in the beginning the principles on which centrifugal pumps work, and had described more fully general forms of construction. It should be said, though, in justice to the author, that this deficiency in his work is due to the ignorance of the general reader, which it is always safe to assume.

From the introductory page of the book to its end it is obvious, though, that it is the work of an expert in the subject of which it treats. In writing he has not taken the trouble often to explain the processes and reasons which have led him to reach his conclusions, but in a sort of discursive, conversational way he tells his readers the results of his experience, observation and reflection in dealing with the branch of engineering which he has written. There is a sort of machine shop flavor about what he has written which to many readers is much more stimulating than the speculative class-room style which is now so prevalent in much technical literature. Mr. Richards tells us what he has learned in building centrifugal pumps, and explains the difficulties he has encountered in making them work; and he does this in a very direct and clear way, which is not difficult to understand.

The first part of the book is on Constructive Features, and consists largely of practical observations with reference to their plan, forms and proportions. The second part is a History of Centrifugal Pumps, which we are inclined to believe might have been more fully elaborated, and many readers will heartily agree with what is said in a foot-note on page 35, that "it is to be regretted that notes of the various references consulted by the author in 1886 have been mislaid or destroyed, otherwise citations would have been given here. The search, mainly in serial literature of the time, was too long to be repeated."

The appendix consists of communications from engineers and makers of centrifugal pumping machinery on the Pacific coast, which will interest many readers. Altogether, Mr. Richards's essay may be described as a practical book by a practical man on a practical subject.

THE CONSTRUCTION OF THE MODERN LOCOMOTIVE. By George Hughes, Assistant in the Chief Mechanical Engineer's Department, Lancashire & Yorkshire Railway. New York: Spon & Chamberlain. 261 pp., 5½ × 8¾ in. Price, $3.50.

Usually a reviewer can get at least some idea of the character and scope of a book from the title and the author's preface. In the present instance the title, "The *Construction* of Locomotives," and the statement in the preface that the design of locomotives has not been touched upon, as it does not come within the scope of the author's plan, gives a clew to the general purpose of the writer, who has divided his subject into three sections: The Boiler; The Foundry, and Forgings. The second of these treats of the Iron Foundry; The Use of Steel Castings; and the Brass Foundry. The third is on the Forge; Smithy, including Springs; Coppersmiths' Work; the Machine Shop and Erecting. The last two subjects, it would seem, should have been treated in a separate section.

That it should be impossible to treat the subject of "boiler construction" exhaustively in 36 pages of about 375 words on each is obvious. Twenty-seven pages are devoted to the Iron Foundry, 31 to the Brass Foundry, 56 to Forgings, nine to Coppersmiths' Work, 45 to the Machine Shop, and 23 to Erecting. Obviously the treatment of all these subjects must be and is superficial. Nevertheless, the author gives his readers much interesting and valuable information in a style which may be described as a kind of technical prattle. The book is written somewhat as some loquacious women talk. The author seems to be full of his subject, and has an immense amount of information which he proceeds to record in a discursive sort of way, without troubling himself to reduce it to any systematic order. Evidently he knows a great deal about his subject, but probably is more at home in a machine shop than at an author's desk. The book is full of hints and suggestions which will be interesting to the novice, and many of them to the veteran in locomotive building. The value of the book for the former would, however, have been much increased if the descriptions and explanations had been made more elementary and comprehensive, and to experienced mechanical engineers it would be more interesting if it had been made less elementary. As it was written it hardly seems to meet the wants of either class fully, although persons belonging to each can read it with interest and profit.

It is illustrated with over 300 outline engravings, most of them very poor "process" illustrations, for the badness of which there can be no adequate excuse in these days of cheap engraving. Some of the drawings, too, are hardly up to the standard to which the illustrations in such a book at the present day should conform. The one on page 14 is an example. Nearly all the illustrations are, however, made from original drawings, which merit will cover many sins.

The frontispiece is a folded plate printed from a wood-engraving, and represents a six-wheeled coupled "goods" engine designed Mr. John A. F. Aspinall, Chief Mechanical Engineer of the Lancashire & Yorkshire Railway. A sectional view of this engine is given in the chapter relating to Erecting, and other views showing it or its parts in successive stages of construction will give a student or apprentice a very good idea of the processes by which the parts of a locomotive are assembled and put together.

The chapter on Steel Castings is a new one in a book on the locomotive, and is demanded by the extended use which is now made of that kind of material. A list of parts which are made of steel castings on the locomotive referred to shows that their use is somewhat more extended in English practice than it is in this country.

The book may be read with interest and profit by any one who is engaged either theoretically or practically in the construction of locomotives, be he student, designer, apprentice, mechanic, or superintendent of motive power; but it belongs to that class of publications which makes the reviewer wonder why the author, having taken as much trouble and shown the ability he did to make the book as good as it is, did not devote more thought and work to it and make it a great deal better.

BOOKS RECEIVED.

Practical Notes on Rope Driving. By M. E. Reprinted from the *Street Railway Journal*.

Annual Report of the Chief of the Bureau of Steam Engineering. Washington: Government Printing Office.

Aerial Navigation. By A. F. Zahm. Johns Hopkins University (reprinted from the *Journal of the Franklin Institute*).

The Measurement and Division of Water. Bulletin No. 27 of the Colorado State Agricultural College, Fort Collins, Col.

The Elementary Principles of Mechanics. Volume I, Kinematics. By A. Jay DuBois, C.E. New York: John Wiley & Sons.

Report of the Chicago Strike. By the United States Strike Commission Appointed by the President, July 26, 1894. Washington: Government Printing Office.

Accurate Tables of Diameters, Areas, Weights, etc., of Cold-Drawn Seamless Tubing. Calculated and Published by O. J. Edwards, Ellwood City, Pa.

A Discussion of the Prevailing Theories and Practices Relating to Sewage Disposal. By Wynkoop Kiersted, C.E. New York: John Wiley & Sons.

Annual Report of the Chief of the Bureau of Construction and Repair to the Secretary of the Navy of the United States. Washington: Government Printing Office.

Transition Curves. A Field Book for Engineers, Containing Rules and Tables for Laying out Transition Curves. By Walter G. Fox, C.E. New York: D. Van Nostrand Company.

Central Station Book-keeping and Suggested Forms. With an Appendix for Street Railways. By Horatio A. Foster, C.E., Member American Institute. New York: The W. J. Johnston Company, Limited.

R. F. Downing & Co.'s New Tariff of United States Customs Duties. Containing full copy of the Customs Tariff Act of 1894 and the Customs Administration Act of 1890. New York: R. F. Downing & Co.

Catechism of Car Painting. By Frederick S. Ball, Master Car Painter, Pennsylvania Railroad, Altoona, Pa. Reprinted from the Proceedings of the Master Car and Locomotive Painters' Association by the *Railroad Car Journal*. New York.

TRADE CATALOGUES.

Messrs. Beamen & Smith send us what they call their "Special Pamphlet No. 1," which is a little sixteen-page folder, illustrating and describing their horizontal spindle drilling and boring machine and its uses. The illustrations are outline drawings, and show very clearly the uses to which this machine may be put. The last page contains illustrations of milling machines made by this firm.

1895 Illustrated Catalogue and Price-list of the Lunkenheimer Company, *Manufacturers of Superior Brass and Iron Valves, Lubricators, and Steam Specialities*. Cincinnati, O. 107 pp., 6¼ × 9 in.

In this book the publishers give illustrations, descriptions, and lists of the various sizes and kinds of articles which they manufacture. These include, first, a great variety of gate, globe, check, throttle, and safety-valves, cocks, whistles, low-water alarms, water-gauges, and columns, steam-gauges, lubricators, oil injectors, etc. By actual count the book contains 185 engravings, which will be an indication of the variety of articles which this Company manufactures.

Cutters, Brown & Sharpe Manufacturing Company, Providence, R. I. 24 pp., 6 × 9 in.

This publication is devoted especially to the illustration of milling "cutters," which are made by this Company. In the preface it is said that "most of the illustrations are selected to suggest our facilities for special work." The engravings are half-tone work, and with the exception of one are nearly full size, and include an involute gear cutter, side milling cutter, several special forms of cutters, metal slitting saws, a large milling cutter, others with inserted teeth, and a gang of cutters. This illustrative pamphlet gives an idea of the great variety of work which is now done on milling machines, the use of which seems to be extending more and more each year.

Modern Methods of Handling Fuel, *as Practised in Locomotive Coaling Stations, Electric Light, and Street Railway Power Plants*. The Link Belt Machinery Company, Chicago, Ill. 24 pp., 7¼ × 9 in.

The manufacturers have here given a series of half-tone engravings of 10 different coaling stations on railroads; then some views in boiler-rooms, coal pockets, conveyors, and other coal handling plant, etc. The last engraving represents a view in the boiler-room of Swift & Company, at the Union Stock Yards, Chicago, and shows a "Standard" water-tube boiler furnished by the Link Belt Machinery Company.

The illustrations are all very good, but would be more effective, it is thought, if they were printed in black instead of blue ink, as they are.

The Maydole Hammers. Manufactured from solid crucible cast steel by the David Maydole Hammer Company, Norwich, Chenango County, N. Y. 32 pp., 6 × 9¼ in.

This book is an illustration of how an art is evolved, as Herbert Spencer says, "from the homogeneous to the heterogeneous." It is an advance from the simple to the complex. A hammer would seem to be a very simple implement, and yet here we have such tools designed for a dozen different purposes, each kind with some special feature to meet the requirements for which it is used. There are nail hammers, hammers for farriers, horseshoers, blacksmiths, engineers, carriage ironers, machinists (four styles), coopers, tinners, riveting, boiler-makers, brick-layers, stone-cutters' and masons' hammers, all of which are represented by good engravings, printed in two tints.

Illustrated Catalogue of Bell's Improved Patent Steam Hammers. By David Bell, Builder of Iron Ships, Iron and Steel Steam Yachts, Engines and Boilers, Improved Propeller Wheels. Buffalo, N. Y. 24 pp., 5 × 6 in.

The author in his catalogue gives us first a picture of himself, which makes us acquainted with him; opposite to this his publication contains a picture of his office and works. After these there is a description and very good wood-cuts of the steam hammers which he makes. These are of the variety which have a large piston-rod which acts as a guide to the hammer-head. Four sizes of these are illustrated, and a long list of names of firms and companies which are using these machines. Some views in the beautiful city of Buffalo, and also one of a lake ship and "Bell's speed propeller wheels," complete it.

The Thurman Fuel Oil Burner Company's System of Burning Crude Petroleum, *as a Substitute for Coal, Coke, and Wood for Boilers, Furnaces, Forges, Ovens, Driers, Brick-Kilns, Potteries, etc.* 36 pp., 6 × 9 in.

This pamphlet opens with advertisements of this device, which are followed by engravings showing a perspective view of the boiler plant at the Columbian Exhibition. Outline engravings and descriptions are then given, showing the application of the device to steam boilers, forges, kilns of various kinds, and a sand-drier. These descriptions are followed by testimonial letters, and the volume concludes with several articles in which the advantages of oil as a fuel are set forth. A small folded circular was also sent with the pamphlet describing the application of the burner to grates and other domestic purposes.

Steam, Hydraulic, and other Cranes. Craig Ridgeway & Son, Coatesville, Pa. 40 pp., 6¼ × 9 in.

The manufacturers in this pamphlet illustrate and describe different kinds of their "Balanced Steam Hydraulic Cranes," which are a specialty of their manufacture. These are nearly all of the jib variety, which are operated by a vertical cylinder which is suspended alongside the center post opposite to the jib. The piston is stationary, and is attached at its lower end by a jointed connection to a tank or reservoir partly filled with water. The power is obtained by admitting steam to the top of this tank above the surface of the water, which is protected by a baffle-plate or float, so that the steam does not come in contact directly with the water. The pressure on the water produced by the steam is communicated to the cylinder and piston, through the action of which the crane is operated. Cranes for a variety of purposes, such as foundries, blast furnaces, rolling mills, etc., are shown. The Company also

manufacture air-hoists, of which they illustrate a variety adapted for different purposes. The illustrations are wood engravings and outline "process" reproductions, and show the different forms of cranes to very good advantage.

HOWDEN HOT-DRAFT SYSTEM. *Its Economy, as Compared with Natural Draft.* 16 pp., $5\frac{1}{4} \times 6\frac{1}{4}$ in.

PERFORMANCE OF THE STEEL STEAMER, *Harvey H. Brown.* The Detroit Dry Dock Company Detroit, Mich. 21 pp., $5\frac{1}{4} \times 6\frac{1}{4}$ in.

The first of these pamphlets gives a description of the construction of the Howden hot-draft system for marine boilers and a statement of its advantages, and gives engravings which represent sectional views of a boiler, with this appliance. These are printed in red ink, which, it is thought, detracts somewhat from their clearness. The construction is explained, and a history is given of the development of this invention, which has been extensively applied to steamers in Europe.

The second pamphlet gives a report of an experimental test of a round trip of the steamer *Harvey H. Brown*, which was made in the lakes while carrying iron ore from Lake Superior ports to Lake Erie ports. The tests were conducted and reported by George C. Shepard, of Cleveland, O. The dimensions of the ship are given, a synopsis of log, indicator diagrams and data, and general results of the test. The Detroit Dry Dock Company are the sole owners and manufacturers of the Howden hot-draft system for the lakes.

THE JOHNSON RAILROAD SIGNAL COMPANY, RAHWAY, N. J., *Reference Book of Parts in Connection with Interlocking and Block Signaling.* 241 pp., $4\frac{3}{4} \times 7$ in.

In the preface to this book the Johnson Company say: "We have purposely limited its scope to the extent of dealing only with detail parts, in order to facilitate the ordering of a complete device or any part thereof.

"It is our intention to issue a new general catalogue, having reference more especially to the science and art of railroad signaling, and showing by diagram and explanation what we consider the best practice in connection with the various branches of the art."

The book is beautifully printed, and bound in limp morocco covers with round corners. The frontispiece shows a view of the works at Rahway, and on the next page is a view of the exhibit of the Company at Chicago, and on page 5 is a view of the Johnson No. 1 interlocking machine. Most of the engravings which follow these—and there are a great many of them—are outline views of details of signal apparatus, although there are some half-tone views made from photographs. As the publishers say, "All the devices illustrated are numbered in order that they may be unmistakably referred to, by naming the page on which the device is shown and its number."

It is an admirable specimen of a catalogue of this kind, is of convenient size, and is all in the very best taste excepting a few errata noted in a slip at the beginning of the volume.

It is copyrighted, and the publishers have adopted the excellent plan of offering it for sale to the general public at the price of $3.

CATALOGUE OF APPARATUS, *Manufactured and Sold by the Sperry Electric Company.* Cleveland, O. 38 pp., 6×9 in.

This admirably printed and beautifully illustrated catalogue is another illustration of the truth of the remark of Herbert Spencer, that "of constructive imagination, as displayed in good exposition, men at large appear to be almost devoid." The Sperry Company have illustrated their motors for electrical cars with beautiful half-tone engravings made from photographs, and have said a great deal about the merits of their system, but have not described it so that any one who has no knowledge of it can understand it. The further observation of Spencer that "good exposition implies much constructive imagination. A prerequisite is the forming of true ideas of the mental states of those who are to be taught; and a further prerequisite is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conception they do not possess." The author of the pamphlet before us obviously has little of this "constructive imagination," and one wanders through the pages vainly in the effort to understand the mechanism which it is there attempted to describe. The engravings are excellent. The one opposite page 5 is faithful to the minutest detail, even to representing the policeman on the rear platform, who looks as though he might be a subject for investigation by the Lexow Committee; but there is nothing in this picture and little in any others which helps us to understand how these cars are propelled. The same thing may be said of the description of the electric brake in the back part of the publication. The brake is highly commended, but the reader who is ignorant of its construction, who can understand it from the description given, must be a very astute person, and have more "constructive imagination" than most readers have.

REFERENCE CATALOGUE (No. 2), GIVING DETAILED PLANS, ILLUSTRATIONS AND DESCRIPTIVE LIST OF INTERLOCKING AND SIGNALING APPARATUS, Manufactured by the National Switch & Signal Company, Easton, Pa. 154 pp., $7\frac{1}{2} \times 10$ in.

A reviewer of trade catalogues is compelled at times to wonder where luxurious typography, paper, binding, and engraving will end. The volume before us, with the exception of the cover, is not showy, and yet everything in it is of the very best, and seems exactly suited to its purpose. The cover is of limp morocco stamped with a specially designed title of the company, with two semaphores, one in the safety and the other in the danger position. The frontispiece is a good half-tone engraving of the works, which is followed by the same kind of an illustration of their interlocking machine. In the preface it is said that this "catalogue" includes "such plans, details and descriptions as appertain more directly to that branch of the art generally called mechanical work; and while a few half-tone pictures of electrical devices are shown, the details and further illustration are reserved for a future edition."

The principal portion of the book is devoted to the illustration and description of the details of different parts of signals and gives the numbers by which they are designated. The system of numbering is a modification of the Dewey system which is explained. The engravings are shown in white lines on a blue ground, and represent blue prints very closely. They are all admirable examples of clear, neat drawings, with nothing superfluous, and yet they show everything that is required to be shown. In some few cases the reduction of the drawings has been so great that definiteness of the engravings has been lost, but that is only in a very few instances, as on page 92.

The last part of the book contains half-tone engravings of a two-arm dwarf signal, the National Company's double wire compensator, a torpedo signal, several illustrations of an electric slot and semaphore, the National block signal and its motor. A view on the line of the Central Railroad of New Jersey, showing one of the automatic semaphores in advance of a cut and curve with the signal cabin, and a good index complete this admirable publication.

NOTES AND NEWS.

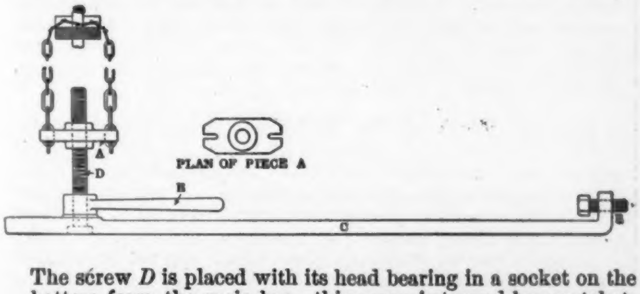
The Three New Torpedo Boats.—The three new boats of this class which were authorized by the Naval Appropriation Bill will, it is said, in general plan follow the design of the *Ericsson*, and have a speed of about $24\frac{1}{2}$ knots. This will fall far short of the speed of the new Yarrow and Thorneycroft boats, or even of those of Schichau and Normand. The reason for this, it is said, is that the appropriations and the dimensions to which the boats are limited will not admit of as high a speed as has been attained by some of the most recent foreign boats. The *Hornet*, it will be remembered, reached a speed exceeding 28 knots as a maximum; and the *Daring*, another Thorneycroft boat, reached the striking speed of 29.268 knots for a single knot. The *Adler*, built by Schichau, of Elbing, for Russia, reached the great average of 27.4 knots. A couple of Yarrow boats built for Italy reached a speed of 25.1 and 24.96 knots respectively. The *Forban*—now building by Normand, of Cherbourg—is said to have a designed speed of 30 knots; and an aluminum torpedo-boat is spoken of which it is expected will have the astonishing speed of 31 knots. In the mean while, much doubt is expressed with reference to the actual value of torpedo-boats in naval warfare.

Oil Burning on the Austrian State Railway.—The *Zeitung des Vereins* publishes the following report regarding some tests of oil burning which have recently been made on the Austrian State Railway. Excellent results have been obtained from these tests, and they show that it is possible to obtain complete combustion without any smoke by using injectors which throw the liquid fuel over the lighted coal in such a way that mixed with the quantity of air necessary, the combustion is complete. The liquid fuel, which is the residue of the petroleum, is placed in the tank of the tender, and which

in winter time is heated to prevent coagulation. The action of the oil is so energetic that the steam pressure of a locomotive heated in this way can be raised in three minutes from three to ten atmospheres, while with coal alone 6¼ minutes are required. On long runs the steam pressure can be kept at maximum pressure, while the engineer has absolute control of the fire, which he can check or increase in intensity as production of steam may require. This method is to be applied to the engines of the Metropolitan Railway of Vienna. It is a system designed by Mr. Holden of the Great Eastern Railway of England, which has been described in previous issues of this paper.

Superheated Steam.—The economical advantages of superheated steam are claimed to be exhibited in a remarkable degree by the Serpollet motor, lengthy accounts of which have appeared in the foreign papers. This motor is described as having a single horizontal cylinder of 5$\frac{1}{16}$ in. in diameter and stroke; the cut-off was fixed at 66 per cent. of the stroke, the admission pressure was 58 lbs. per square inch, and the revolutions 284 per minute. The brake H.P. on a four hours' trial averaged 4.57 H.P., and the steam consumption was but 29.87 lbs. per brake H.P. an hour. The advantage thus indicated is credited to the boiler, which supplies superheated steam; this boiler consisting of a stout tube flattened so as to deform the passage through into a narrow slit. The tube is coiled, and has one end connected with a feed pump and the other with the engine to be driven. The boiler used in these tests had a heating surface of nearly 27 sq. ft., and the grate area was nearly 3 sq. ft. The steam, though showing on the gauge a pressure of 58 lbs. per square inch only, had a temperature of 1,009° F. on issuing from the coil, which had fallen to 572° at the steam-chest; the temperature of saturated steam at 58 lbs. pressure is about 306°, so, as used in the engine, was superheated by some 266°. The output of steam was 4.9 lbs. per square foot of heating surface per hour; the fuel used was briquettes having a heating power of 8.28 lbs. of water, 212° per pound of fuel.

Device for Removing Driving Springs.—A little device which we illustrate herewith, is one that is in use in the Middletown shops of the New York, Onario & Western Railway, for removing driving springs. It consists of a bar, *C*, turned up at one end, and provided with a set screw, *B*; this bar is intended to have one end slipped under the head of the rail and the other to be held by the set screw *B*, the end coming under the other rail head directly beneath the location of the springs.



The screw *D* is placed with its head bearing in a socket on the bottom from the main bar; this screw is turned by a ratchet, and *E A* is a nut of the shape shown; it is run up on the thread of the screw, and the chain laid over the spring and caught in the notches *A* as shown; the screw is then turned and drawn down until the chain tightens and the spring compressed sufficiently for the removal of the keys. It is a home-made affair, but very handy for round-house work.

A Tank on a Smokestack.—A novel use of a smokestack has been made at a French industrial establishment. Where an elevated tank was desired for storage of water and to give pressure, the main smokestack of the works was utilized as a pedestal, and the tank was thus elevated 75 ft. above the ground at a minimum expense. The tank is annular in form, the inner and outer walls being concentric with the chimney and a little distance removed from it. The tank is supported on a stone sill ring built into a brick corbel on the chimney, and is held by radial angle-iron struts. Ladders pass between the tank and the chimney and down into the tank, which has the customary supply, discharge and overflow pipes. An umbrella-shaped sheet-iron roof covers the tank and probably has orifices to permit a circulation of air in summer and prevent it in winter, as it is stated that the annular air space prevents any appreciable warming of the water from the hot gases in the chimney, while sufficient heat is received to prevent freezing in winter. The volume of the reservoir is about 3,532 cub. ft., its weight, empty, 11 tons, and 122 tons when full. No statement is made concerning the location of this chimney, but it would appear that where foundations are easy and ample such a utilization of a smokestack for a tank pedestal might prove convenient and economical if the construction were not too unsightly, and if sufficient stiffness or ample guying against the possible great wind strains is provided.

Armor Plate Tests at Bethlehem.—Another successful test of the Bethlehem Iron Company's armor plate was made early in October at the company's proving ground. The plate tried was one representing 300 tons of armor for the battleship *Texas*, and all were accepted by the Government officials. The plate is 12 in. thick at the bottom and tapers to 6 in. at the top. It is 18 ft. long and 6½ ft. wide, Harveyized, and weighs 50,000 lbs. Two shots were fired at it from an 8-in. gun. The point of impact of the first shot was 6 ft. 6 in. from one side and 34 in. from the bottom of the plate. A 250-lb. Holtzer projectile was shot at the plate with a charge of 79½ lbs. of hexagonal powder, at a velocity of 1,678 ft. per second. The projectile was badly upset, and a portion of it remained in the plate, making it difficult to determine the penetration, but the Government officers estimated it at 6 in. In the second shot 110 lbs. of powder were used, and the same weight and kind of projectile. The velocity was 2,004 ft. per second. The point of impact was 40 in. from the side and 31½ in. from the top. The result was almost the same as that of the first shot. The shell was smashed, and a large part remained imbedded in the plate. The penetration was estimated at 8 in. Neither of the shots caused any bulging of the plate, and there was no disturbance of the backing or springing of the bolts that held the plate fast to the large timbers. The plate fired at was selected for the test because it was believed to be the poorest in the lot.

A Light Experimental Railroad.—The London *Times* recently published the following account of a light, narrow-gauge railroad with which a gentleman in England has, apparently, been amusing himself for some time past. Of this road it is said:

"Mr. A. Percival Heywood, son of Sir Percival Heywood, having lately added largely to the rolling stock and capabilities of his light railway of 15 in. gauge, invited recently a number of friends and others interested in cheap transport to inspect the working of the line at Duffield Bank, near Derby. Two small locomotives, coupled all round, with flexible wheel base and other improvements, were shown in steam, and closed and open bogie carriages conveyed visitors over the line, half a mile of which was arranged to admit of continuous runs. Dining and sleeping cars, together with goods wagons, vans, etc., conveying various loads, were shown at work. A dynamometer car, fitted with instruments to indicate the power and speed of the engines, was also exhibited. The visitors inspected the amateur workshops and foundry adjoining, where the locomotives and rolling stock were constructed.

"The primary object of the exhibition was to solve the various problems involved in the successful designing of engines, carriages and roadway of the narrow gauge. The chief ends in view were, first, the application of narrow-gauge lines to agricultural and commercial purposes, and, secondly, to the requirements of military transport in countries destitute of roads. The latter point some years ago engaged the attention of the Royal Engineers.

"The construction of this line of 15-in. gauge was begun in 1874, and various additions were made up to 1881, when the length laid amounted to about a mile, inclusive of sidings. Since the latter date there has been no material extension, but the permanent way and its accessories have been improved. The line runs from the farm and workshops up a gradient, varying from 1 in 10 to 1 in 12, about ¼ mile long, to a level 80 ft. above, where the experimental course is laid out in the shape of a figure 8, so as to admit of continuous runs. This part, somewhat more than ½ mile in length, has a level stretch of ¼ mile, the remainder consisting of gradients of which 1 in 25 is the most severe. The maximum curve on the main line is of 25 ft. radius, but in the sidings some occur which are as sharp as 15 ft. radius. The permanent way was at first laid with 14-lb. rails, without fishplates, spiked to elm or Spanish chestnut sleepers, felled and sawn on the premises. The line is properly equipped with interlocked signals and points on a very simple plan. There are on the railway three tunnels, two bridges, and a viaduct 90 ft. in length and 20 ft. high. The latter was built in 1878 as an improvement upon a very rickety one erected by Mr. Fell at Aldershot, when he induced the War Office to sanction an experimental line for army transport purposes. In addition to a number of wagons, some of which are fitted with brakes, there are on the line seven bogie passenger cars and a bogie van, as well as a variety of miscellaneous stock such as workmen's cars, screw and roller

rail benders, and dynamometer car. Mr. Heywood has also built a dining car and a sleeping car of the same dimensions as the cars already described.

"With regard to the locomotives themselves, they are probably, for their weight, the most powerful and flexible ever built to work by simple adhesion. It appears that the officers of the Royal Engineers have been trying the engine with a view to adopting the plan on the military railway at Chatham. They subjected it to very severe tests, loading it up steep inclines to its utmost capacity, stopping it with the steam brake almost dead when traveling at various speeds, and over the most awkward places, and finally giving it a 50-mile run with all the load that could be got together at an average speed of 7½ miles an hour, stops being made for water, etc., for 12 minutes in each hour. This was followed shortly afterward by a continuous run with a similar load for 1 hour and 35 minutes, the extreme limit to which the water in the tanks would hold out. There was no heating of any part during the trials, nor failure of any kind. After 8 years' work, chiefly on gradients of 1 in 10 to 1 in 12, where sand has to be used freely, the engine came into the shops to be overhauled. During this time there had been no mishap or breakage whatever, nor had a wheel ever left the rails except on one occasion."

This description has called out considerable correspondence and discussion of the subject of light railroads, and has elicited a letter from the engineer of a light railway, of which, apparently, little is known. The following quotation is from this letter:

"Incidentally, I have been somewhat surprised that no allusion has hitherto been made to the Swansea & Mumbles Railway (for which I am engineer), authorized by special act in 1804—one of the oldest and, I believe, most successful railways of this description in the kingdom, and fulfilling all the essential principles advocated by your correspondents, carrying a very large traffic, chiefly in passengers, but much general goods also. I venture to think this railway worthy of considerable attention, as showing what has and can be done in this direction in this country.

"I entirely agree that such railways in many rural and other parts of the country, connected at stations with the existing railways, are most desirable and the right thing, and in this opinion the late Mr. Grierson, one of the most capable railway managers of his day, entirely concurred; but I wholly disagree that they should be made of a different gauge, or that there would be any real economy in such light permanent way as it seems most of your correspondents contemplate. The reasons for this are obvious, but to explain them in detail would be too great a tax on your space. S. W. YOCKNEY.

"46 Queen Anne's Gate, Westminster, S. W., August 31."

Compound Locomotives on the Northwestern Railway of Switzerland.—The Northwestern Railway of Switzerland has had a number of simple and compound locomotives built by the Winterthur shops; they are identical in all parts, with the exception that in the compound engines the high-pressure cylinder on the left side, which is 15¾ in. in diameter, is replaced by a cylinder 22¾ in. in diameter, taking steam from the right-hand cylinder by way of a pipe passing through the smoke-box. To facilitate the starting, an inner starting valve is used, which allows live steam to be admitted directly into the large cylinder when the throttle valve is opened. The object of this identity in the construction of the engines is to permit of comparative tests being made of the consumption of fuel, which have been carried on for about nine months, starting in August, 1893, and extending through to April, 1894. For this purpose two types of engines were successively detailed to haul the trains for the same number of trips. Furthermore, the engine crews were transferred alternately from one to the other. In a word, the conditions of running were kept rigorously the same throughout the whole of this period. The average monthly run to each engine was 2,625 miles, with an average train load of 21.17, axles loaded to five tons each. The consumption of coal has been taken from month to month, and has resulted in showing a gain of from 15 to 16 per cent. in favor of the compound locomotive. Under these circumstances the company has decided to extend the use of these engines over its system, and has ordered six new ones from the Winterthur shops.—*Schwerzerische Bauzeitung.*

Life on an Iron-Clad at Sea.—Admiral von Werner, a high authority in naval matters in Germany, describes in a work recently published the behavior of armor-plated men-of-war in a heavy sea. He says: "Even with a moderate gale and sea, an armor-plated cruiser, if going against the wind, will find herself in conditions similar to those of a storm—at least the crew will have that impression. The movements of the stern of the ship are violent and exceedingly disagreeable. The waves, pushed by the advancing prow, sweep continually over the ship from bow to stern. All windows and portholes must be closed, and air reaches the lower decks, where the heat increases unbearably, only through the artificial ventilators. With the exception of the specially protected command bridge, all the uncovered portions of the ship are impassable; thus the whole crew must bear as well as they can the hell of the closed decks. On such a ship no one can feel comfortable; and when there is a storm in which a sailing ship would feel comparatively at ease, the crew of an armor-plated ship imagines itself to be in a heavy hurricane which threatens destruction at every minute. The long, narrow forepart of the ship, which is not borne lightly by the water, and is rendered extremely heavy by the mighty ram and the armored deck and the cannon and torpedoes, forces the ship in a high sea to pitchings and rollings of such an extraordinary kind that they cannot be described. The crew of such a ship is not only exposed to mortal dangers, but the voyages they make render them physically extremely and dangerously nervous; the mental impressions they receive wear them out and make the profession hateful."—*St. James's Gazette.*

The Effect of Firing Two Big Guns at Once.—The effects of two 10-in. turret guns being fired simultaneously are rather astonishing. A correspondent who was on one of the vessels taking part in the manœuvres graphically describes the effect of the concussion. He was leaning close to the turret, and while thus occupied the guns were fired. "For several moments," he says, "I wondered what hit me and where I was hit. I had been regularly lifted by the concussion, but came down quite whole." The glass that protects the helmsman from the weather and the windows in the chart house, the glass of which is ½ in. thick, were smashed to atoms. An ink-bottle that stood on the table in the chart house jumped about 6 in., and every drop of ink sprang out, but the bottle dropped back to the spot from which it jumped. Three water bottles and three tumblers were on the table in the smoking-room, both being full of water. When the guns were fired the bottles and the tumblers jumped into the air. Three gentlemen who were in the room also left their seats. The bottles and tumblers fell back into their old places, but every drop of water had been spilled upon the table, though nothing had been broken. The doctor was about to extract a tooth from a patient, and had just got the forceps in the right place and taken a firm hold when the double explosion occurred. Both he and the patient were lifted, and when they came down again the tooth was out. The doctor said he had not pulled, and the patient said he had not felt the tooth coming out. And in one of the cabins the bath-tub had been jarred off two of the three hooks by which it was fastened to the ceiling, and was hanging by one hook.—*English Court Journal.*

Machine Work of the Bethlehem Iron Company.—An officer from the Navy Department, in speaking of the work which has been done for the Navy Department by the Bethlehem Iron Company, referred to the shafts of the *Raleigh* and *Cincinnati*, and said that when they were delivered to the Navy Yard it was found necessary to put them in the lathe in order to do some special fitting on them which had not been called for in the specifications given to the Bethlehem Company. In order to do this, plugs were turned up and driven into the hollow shafting, and these latter were found to be perfectly straight, 6 in. in diameter through a 13-in. shaft, and the testing of them with calipers from end to end could detect no variation in the diameters; and when they were finally swung in the lathes on these plugs they ran as true as though they had been on their original centers. The template which was made for the thrust bearing for one of these shafts was found to fit so accurately on the thrust bearings of the other three, two being used for each ship, that on only two of the collars of the whole four could the faintest glimmer of light be seen when the template was in position. Everything was polished and given a smooth water finish, as fine as that put upon the finest and smallest of work. When the eccentrics were to be bored out, it was found that one template was insufficient for boring out all of the eccentrics for all of the engines, the shafts being so accurately turned that any eccentric could be used in any position. When we take into consideration the size of the work done and the accuracy, it certainly speaks well not only for American mechanism, but also for the care and accuracy of the work done by the Bethlehem Company.

Ownership of Railroads.—The Interstate Commerce Commission has recently compiled some interesting statistics regarding the ownership of railroads by foreign governments, which may be summarized as follows:

"It appears that 10 countries do not own or operate rail-

ways—viz., Colombia, Great Britain and Ireland, Mexico, Paraguay, Peru, Spain, Switzerland, Turkey, United States and Uruguay. The following governments own and operate some of the railways: Argentina, Australasia, Austria-Hungary, Belgium, Brazil, Canada, Cape of Good Hope, Chile, Denmark, France, Germany, Guatemala, India, Japan, Norway, Portugal, Russia and Sweden—18. The following governments own part of their railways, but do not operate any, leasing all the present mileage to private companies—viz., Greece, Holland and Italy. Though not claimed to be accurate, it is believed that the foregoing summary represents an approximately correct statement of the relation of the various governments to the railways of the world. The relative rates charged for freight and passenger service on the government-owned railroads, and the facts cited in connection with such roads, are calculated to afford little encouragement to the advocates of government ownership. A comparison of passenger charges per mile shows an average in Great Britain of 4.42 cents for first-class, 3.20 cents for second-class and 1.94 cents for third-class. In France the average is 3.86 cents for first-class, 2.86 cents for second-class and 2.08 cents for third-class. In Germany the rate is 3.10 cents for first-class, 2.32 cents for second-class and 1.54 cents for third-class. In the United States the average charge is 2.12 cents a mile. The average charges for freight per ton per mile are as follows: In Great Britain, 2.80 cents; in France, 2.20 cents; in Germany, 1.64 cents; and in the United States, 1 cent. The interest on capital invested in the several countries is as follows: United Kingdom, 4.1 per cent; France, 3.8 per cent.; Germany, 5.1 per cent.; Russia, 5.3 per cent.; Austria, 3.1 per cent; Belgium, 4.6 per cent; United States, 3.1 per cent."

A Trans-Jersey Ship Canal.—At a recent meeting of the Trans-Jersey Ship Canal Commission, held in Philadelphia, it was decided to adopt the report of Lewis M. Haupt, Engineer-in-Charge, and put parties in the field at once to survey two proposed routes. In his report Mr. Haupt found it would be commercially unprofitable to build a canal which it is proposed to extend from Philadelphia to Raritan Bay at tide-water, as there is a general elevation of 100 ft. He suggests two 25-ft. lift locks. The Delaware & Raritan rivers were said to be the only available sources of supply. The two routes suggested both start from Bordentown. One goes through the Raritan River and Bay and the other reaches the sea by way of Monmouth Junction and Raritan Bay. The first has railroad crossings and a surface 52 ft. above the sea level, and the second has no railroad crossing, but would encounter ground 90 ft. above sea level.

French Doctors on Bicycling.—The French Academy of Medicine has recently discussed the healthfulness of bicycle riding and unanimously adopted the following resolution: "That the use of the bicyclette should only be permitted after a serious medical examination of the would-be rider." One of the Paris evening papers sums this resolution up by the remark: "One louis a visit, if you please."

Conundrum.—A correspondent who signs himself "Conductor" propounded the following recently in the New York *Sun:* "In relaying a portion of the track of the Erie Railway three men are bringing in a rail that is 30 ft. long. One takes hold of the end, the other two have a short wooden bar to place under the rail to assist in its carriage. At what distance from the opposite end to where the single man is placed must the two men be in order that each of the three men may bear exactly the same weight?"

Long-Distance Electricity.—It is proposed to supply San Francisco with electric power brought from Clear Lake, 75 miles distant, at which point it is estimated that 30,000 H.P. is available.

The New Navy Yard at Algiers.—Steps have just been taken for the purchase of additional land for the new naval station at Algiers, on the Mississippi, opposite the lower part of New Orleans. The establishment of a dry dock and a navy yard at this point has been under consideration for many years. A commission was appointed under Secretary Whitney, which reported:

"After carefully weighing all the advantages and disadvantages of Algiers as a site for a naval station, the commission is of the opinion that, while the spot is not an ideal one, no other place in the Gulf compares with it in the advantages offered, and that the advantages are so many and so great, and outweigh the disadvantages to such an extent, that the Commission has no hesitation in recommending the location of the Navy Yard and dry dock at the present Government reservation at Algiers."

This report, however, did not finally settle the question; and a second commission was afterward appointed. In general this commission concluded:

"That the site ought to have a deep-water frontage, so as to accommodate ships of the deepest draft. It was considered a further advantage that it should be far enough up some stream to have fresh water, so that the steel ships laid up at its docks would not deteriorate. It must be capable of defense from attacks, either by sea or by land, and would be all the better for being landlocked. It required facilities for inland transportation, with plenty of labor at hand and available, and it should be in a healthy locality."

In its report the commission mentioned as primary requisites for the dry dock, "a clear channel to the sea at least 26 ft. deep, stability of foundation to support a load of 15,000 tons, and protection, either by a distance of 12 miles or by an intervening elevation of ground, from gun fire from the sea." With all other things equal, proximity to a center of commercial and naval interest was held to be a determining element in the selection of a site. Taking these points together, it becomes clear why this second commission affirmed the choice of its predecessor; and if Congress makes the needed provisions for carrying out the plan the plan will be carried forward.

Rolling Stock of the Antwerp Exposition.—At the Antwerp Exhibition there were on view some very interesting specimens of modern rolling-stock. A six-wheeled corridor coach of the Paris & Lyons Company, showing all the finish and careful attention to detail that usually marks French railway carriage building, took my fancy particularly. These were two points which I only wish our English companies would imitate in their sleeping cars, dining cars and other similar vehicles. Most people who have traveled much in this country in sleeping cars in cold weather have known what it is to find their heads next the outside air, with nothing but a thin sheet of glass and a thin blind to protect them, and to have to put their heads under the bed clothes to avoid being frozen, or, what is even worse, waking up with toothache. The Paris & Lyons sleeping-coupés had shutters, hard wood toward the outside, but padded with cloth on the inside to keep the cold out. Again, most of us have known what it is to sit in a dining car destitute of ventilation except by means of a window opening upward just at the height of the tables, which in the first place peppered the soup with blacks from the engine, and in the second place tended to give all but the most robust passengers a bad attack of lumbago. In the Paris & Lyons carriage the upper 6 in. of the large fixed windows were made to open with a sash that slid upward out of sight into the top framing of the coach.

But corridor carriages were by no means confined to the Antwerp Exhibition. Everywhere on the Continent they are coming into use for long-distance express traffic. In Hungary they seem to run almost nothing else, and alike in Austria and South Germany, in Prussia and in Belgium one found them on the important trains. The continental carriage-builders, less conservative than our own home companies, have not hesitated to abolish altogether, in the case of these carriages, side doors and the footboards along the outside as well. The consequence of course is that they are able to give much more room internally than we can afford. No doubt the blocking the gangways at important stations, when numbers of people wish to get in and out, is a considerable objection to the abolition of side doors. But in practice this disadvantage can be reduced to a minimum if guards and platform inspectors will take the trouble to see that no new passenger gets in until the last of the arriving passengers has had time to get out. There is, however, one point in connection with this blocking of gangways of considerable interest. Our American cousins often reproach us with the amount of luggage we take with us into the carriage, but there can be no doubt that continental travelers are in most countries greater sinners in this respect than we are. Nowhere is more than 66 lbs. of luggage allowed free; while no free baggage at all is the rule in all important countries except France and Prussia. Moreover, the tendency among continental railway officials is at present in the direction of greater restrictions, so that the circular tickets with which half the passengers in summer are supplied allow, even in Prussia, no free luggage. Add to all this the intolerable delays caused by the red-tape arrangements for registering and re-delivering baggage, and the reason why the gangways of continental trains are blocked not merely with hand bags, but with Gladstones and portmanteaus becomes sufficiently obvious. Before long some more stringent regulations will evidently need to be made in the interest of the passengers at large. Continental railway writers frequently describe the inclusion of an allowance of free luggage in the price of a ticket as a concession to the rich people who have luggage at the expense of the poor who have none to take. As far as my ex-


FIG. 1

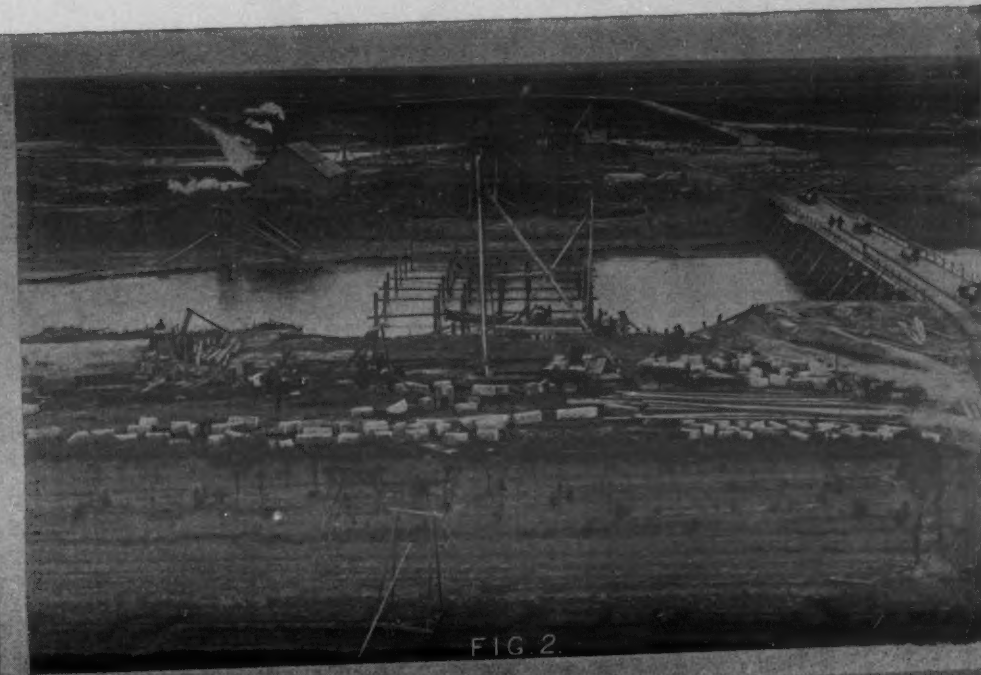


FIG. 2.


FIG. 3.


FIG. 4.

SCENES ON THE GREAT SIBERIAN RAILROAD DURING CONSTRUCTION.

perience goes, the truer formula would assert that the abolition of free luggage means the curtailment of the reasonable comfort of a large number of passengers in order to afford room in the carriage for the heavy baggage of a small number of selfish and callous fellow-travelers.—*Transport.*

PROGRESS IN CONSTRUCTION OF THE GREAT SIBERIAN RAILROAD.

THE Great Siberian Railroad, commenced at its eastern terminus, Vladivostok, in 1891, and at its western terminus, Chelabinsk, in 1892, is now well in progress.

Besides the main line from Chelabinsk to Vladivostok it was decided at the sixteenth session of the Committee of the Siberian Railroad* to build a branch, connecting the Siberian Railroad with the existing Oural Railroad (Perm-Ekaterinbourg-Tumen). From different locations proposed for this branch, the western location—Ekaterinbourg-Chelabinsk—was chosen, which answered best to the needs and interests of many mining works of Oural. This branch was commenced in 1894, and will be completed in 1896, together with the Western Siberian Railroad, the chief engineer of which is Mr. Mikhaïlovski, who is also charged with its construction. The credit obtained for the construction of this line (without rolling stock) is 6,475,258 roubles.

Before giving data concerning the progress in construction of different lines composing the Great Siberian Railroad, I will explain the new plan of the whole construction proposed by the Minister of Finance in the seventeenth session of the Committee of the Siberian Railroad (May 3-15, 1894).

According to this proposition, the Central Siberian Railroad to Irkoutsk can be completed in 1898 (2 years earlier than was supposed); and the whole Oussouri Line—viz., South Oussouri from Vladivostok to Grafska, and North Oussouri, from Grafska to Khabarovka—can be completed in 1896. In consequence of it the committee decided to hasten the surveys of the Baïkal and the Amour Lines, and the construction of the remaining lines in order (1) that in 1898 not only the Siberian Railroad can be carried from its western terminus (Chelabinsk) to Irkoutsk, but that the branch from Irkoutsk to Listvinichnaïa Harbor on the Baïkal Lake will be ready; and the Trans-Baïkal Line can be completed; and (2) that the construction of the Amour Line be finished in 1901.

In the same session the Minister of Ways and Communications asked for credits for the surveys and the location of the Baïkal and Amour lines, and for the beginning of works on the Trans-Baïkal Line.

Having deliberated on the whole subject, the committee has decided:

1. To approve of the beginning of construction of the Trans-Baïkal Line in 1894, and to use for this purpose at present two locomotives, 60 wagons, and rails for 100 versts of line, taking them from the stock prepared for other Siberian lines.

2. To approve the surveys of the Amour and Baïkal Line.

3. And to assign for these surveys credits of 1,000,000 roubles for the former and 250,000 roubles for the latter.

After these general remarks I will proceed to the progress of works on every line.

The Western Siberian Railroad, from Chelabinsk to the Obi River (884 miles long) was begun in 1892, and will be completed in 1896. On its western side the track was laid to Kourhan (160 miles) in October, 1893, and the construction trains have been running from Chelabinsk to this city from October 4, 1893. In the winter of 1893-94 the traffic was opened also for local goods. The earthwork is here typical of the whole Western Siberia; it is performed chiefly by means of hand-barrows (litters), and when the distance is too great, by means of horse-barrows (two or four-wheelers). The Tobol iron bridge (1,400 ft. long; 4 spans of 350 ft., with semiparabolic girders) is now in course of construction, and a temporary timber bridge with loop line was built in order not to break off the track-laying. The illustration (fig. 1) shows this temporary bridge, the Tobol River, the loop line, the provisional water supply (by means of Körting's pulsometer), a general view of Kourhan city, and the store yard of materials for the construction of the permanent bridge.

The foundations of Tobol bridge are designed to rest on caissons, and for four spans five caissons are required. Their depth is from 50 ft. to 60 ft., and the sinking of one caisson requires from 4 to 6 weeks. The sinking of the first caisson was begun December 17, 1893, and the last (the fifth) caisson is now (August, 1894) already sunk. For the work two 25-H.P. engines and two old Vulcan air compressors are used. The removal of earth is performed by means of sacks hoisted by endless wire moved by means of a small 6-H.P. engine.

The annexed illustrations (figs. 2, 3 and 4) show the works of construction of the Tobol bridge—viz.: Fig. 2 shows the pile-driving for false works, fig. 3 the sinking of a caisson, and fig. 4 a group of workmen riveting a caisson.

On July 11 the track was completed to Petropavlovsk (332 miles) and the first locomotive was met by the local authorities with great ceremony.

Near Petropavlovsk the Tshim River is crossed, for which an iron bridge 700 ft. long (two spans 350 ft.) is designed. The girders will be semiparabolic, of the same type as for the Tobol and Irtish bridges.

The track-laying advances rapidly, the conditions existing in a level country being favorable. All the material (rails, accessories and ties) is carried daily by two trains of thirty cars* each. The ties are carried forward by means of horses, and only the rails and accessories are carried by means of small bogies, which are forwarded with the track-laying. The track-laying advances at the rate of from 3 to 4 miles every day. Thus far it has started from Chelabinsk only, but in June it was begun also from Omsk, where rails, accessories and ties have been brought by river navigation. The track-laying between Chelabinsk and Omsk (434 miles) is advancing now from two starting points in both directions, and the last rail on this section it was expected would be laid on August 17, 1894, in presence of the Minister of Ways and Communications, Mr. Krivoshein.

The track-laying will be extended from Omsk eastward 100 miles this year. It will be completed to the Obi River in the summer of 1895.

The Irtish bridge (two of 100 ft. span) will be begun this winter; and the foundations at the Obi River were laid between July 22 and August 3, 1894, in presence of the chief engineers of both the neighboring lines, the Western Siberian and Central Siberian.

The Central Siberian Railroad, from the Obi River to Irkoutsk, according to the last programme, will be completed in 1898. The work was begun in 1893 on the first section, and work on the Obi River, Krasnoïjarsk (480 miles), has been started this year on the whole line. The earthwork has advanced rapidly, and the track-laying has also been started from the Obi River; in 1893 16 miles were laid, and in 1894 it is proposed to lay about 100 miles. The branch to Tomsk (60 miles long) was designed in 1893; but the location of the second section (Krasnoïomsk to Irkoutsk) was begun in 1894.

The terminus of this line (Irkoutsk) is the best and largest city in Siberia; it has 45,000 inhabitants. The railroad station is located on the left side of the Angara River, opposite Irkoutsk City, and is situated on the right side of that river near the estuary of Irkout River.

From Irkoutsk to Baïkal Lake (Listvenichnaïa Harbor) a branch line will be completed in 1898. In this way, and with the steam ferry on the Baïkal Sea in 1898, the European railway system will be uninterruptedly connected with the heart of Siberia at Irkoutsk, and, by the navigation of the Amour River, it will be connected with the Pacific terminus at Vladivostok.

The section of the Great Siberian Railroad (the Baïkal loop line) from Irkoutsk to Misovskaïa Harbor (194 miles) will now be definitely located, and the construction of it will be completed in 1901.

The Trans-Baïkal Line, from Baïkal Lake to Sretensk, on Shilka River (672 miles) is now definitely located, and the construction of it, starting this year, will be completed in 1898.

The Amour Line (from Sretensk, on Shilka River, to Khabarovka, near the estuary of Oussouri in Amour, about 1,300 miles) has not yet been surveyed; but Mr. B. Savrimovich, C.E., has recently been appointed Chief Engineer of Surveys. The surveys will present great difficulties, the country being entirely uninhabited. The construction of this line, crossing an entirely unknown country, will not be completed until 1901.

The last section of the Great Siberian Railroad (the Western

* Presided over by the present Czar, Nicholas II.

* The Russian goods cars carry from 10 to 12 tons.

or Oussouri section) consists of two lines—North Oussouri Line and South Oussouri Line.

The North Oussouri Line (from Khabarovka, the administrative center of the Amour territory, to the Grafskaïa, 232 miles) is now located. Its construction will be begun in 1895, and will be completed in 1898.

The South Oussouri Line (from Grafskaïa to Vladivostok, 254 miles) was the first of the whole system of Siberian railroads which was commenced. Work was started on it in 1891. The construction of this line has been very difficult, and many hindrances have been encountered from the local conditions, want of workmen (a great part of whom were exiles and criminals), and the entire separation from the metropolis. The earthwork was generally very heavy. Nevertheless, 124 miles of track are already laid, is open to traffic, and in the spring of 1895 the whole line will be finished.

THE UNITED STATES TRIPLE-SCREW CRUISERS "COLUMBIA" AND "MINNEAPOLIS."*

BY GEORGE W. MELVILLE, ENGINEER-IN-CHIEF, U. S. NAVY.

THESE two vessels have been more prominently before the public than any other of our new vessels from the first descriptions of their design, and the great success which has attended their official trials has doubtless led the Executive Committee to suggest them as a subject for a paper.

Although I had the honor of recommending the use of triple screws on these vessels, it is hardly necessary to tell this Society that the use of triple screws was not a novelty, and that any credit in the matter arises simply from their use for machinery of much greater power than had previously been attempted, and for persisting in the design against the advice of some of my best friends in the profession, who believed it too much of an experiment.

When I was asked to design machinery of about 21,000 I.H.P. for the *Columbia* there were a number of questions which came up for consideration. One was that of securing economy at moderate speeds when full speed was so high, and another was that of the shafting. When the design was under consideration no steel shaft had yet been made in this country for the transmission of as great a power as 10,000 horses, and while I had every confidence in my friend John Fritz and the Bethlehem Iron Company, I felt that it would be safer to adopt a design which would give us smaller shafting. The alternative to triple screws was twin screws, either with one very large engine or two smaller ones on each shaft. The former meant large parts of the machinery all through, and the latter great multiplication of parts.

The French experiments on the *Carpe*, and the trials of the *Tripoli* had demonstrated that there was no doubt of the practical success of triple screws, and the preliminary design of the *Dupuy de Lôme* with triple screws showed that the French were satisfied with the *Carpe* experiments. I believed, also, that we would find it more economical to run one engine of a size for 7,000 I.H.P. at about 2,000 than to run two 10,500 I.H.P. engines, or even two 5,000 I.H.P. engines, even if it did involve dragging the idle screws, allowed to revolve freely. I had hoped to be able to give some figures on this point, as an attempt was made, during the return trip of the *Minneapolis* from her official trial, to secure a comparison of the horse-power and coal consumption when making the same speed with one, two, and all three screws, but fog and other circumstances interfered, and the speed had to be determined by the patent log, so that the results obtained cannot be considered as at all conclusive. The *Columbia* is now on active service, and by our next meeting I may be able to give reliable data as the averages of considerable periods.

It is, however, obvious that, even if the drag of the two idle screws should require enough additional power to make the actual cost of propelling the vessel at a given speed in pounds of coal per hour nearly as great as the similar cost of driving her by the after engines of twin screws with a pair on each shaft, there is a gain in economy of maintenance and in convenience. We have been compelled in the *New York* and the *Brooklyn* to make special provision for the wearing down of the shaft bearings of the after engine, and in the *Blake* of the English Navy, where the attempt has been made to avoid this difficulty by using the forward and after engines on each shaft alternately, it is necessary to disconnect all the connecting rods and eccentric straps, which is certainly inconvenient, and involves considerable delay when it is desired to use both engines for higher powers.

When the *Columbia* and the *Minneapolis* were designed, we hoped to secure a speed of about 22 knots for the maximum I.H.P. of 21,000, and while some enthusiasts predicted higher speeds, those of us who were more conservative felt that 22 knots was about all we could reasonably expect. The news that the *Columbia* had made 22.8 knots was, therefore, both gratifying and astonishing when the official report showed that it had been made for only about 18,500 I.H.P. This seemed so remarkable that I urged the Trial Board to go over the computation of the H.P. again with great care, which was done without the detection of any error. When the complete data were received I had one of my most capable assistants, an expert in these matters, revise all the work, but he could detect no error anywhere. After this performance it was, of course, reasonable to expect still better results from the *Minneapolis* if she should develop the full 21,000 I.H.P., and, as you know, such was the case, an average speed of 23.07 knots being secured, making her the fastest large vessel in the world, and, for the length of her trial, the fastest vessel, large or small.

In an appendix are given the dimensions of hull and machinery of the *Columbia* and the *Minneapolis*, together with the data of their performances on trial. There is also given a brief historical sketch of the use of multiple screws prepared by one of the younger officers of the Engineer Corps, Passed Assistant Engineer Thomas F. Carter, U. S. Navy, and first published in the *Journal* of the American Society of Naval Engineers, and this will undoubtedly prove interesting.

As already remarked, the economy of propulsion in the case of the *Columbia* was so marked as to suggest comparison with other fast vessels, and it was at once apparent that the gain in economy was considerable. A natural comparison is with the *New York* and the *Olympia*, and I have brought the *New York* and the *Minneapolis* to the displacement of the *Olympia* by Froude's law. As the vessels are all of considerable size, the error due to not calculating the frictional resistance separately is negligible. Inasmuch as the speeds thus found are not all the same, and as it is desirable to make the comparison at the same speed, I have calculated the exponential relation of speed and power from a curve for a 5,000-ton vessel constructed by Froude's Law from the progressive trials of another ship where speed and power were determined with unusual care. Calling the ratio of speeds a, and the ratio of powers b, we have $a^x = b$, where x is the exponential relation desired. Then $x \log a = \log b$, and $x = \dfrac{\log b}{\log a}$.

Taking speeds and powers as follows :

	Speeds.	Powers.
(1)......	15.00	3,175
(2)......	17.60	6,230
(3)......	19.90	10.150

we get the following table :

RATIOS.	Speeds a.	Powers b.	Log a.	Log b.	x.
1 : 2	1.17	1.96	.0682	.2923	4.28
1 : 3	1.325	3.20	.1222	.5051	4.12
2 : 3	1.13	1.63	.0531	.2122	4.00

We shall not be far wrong then in assuming that the powers vary as the fourth power of the speeds.

Applying Froude's Law, and bringing the speeds of *Olympia* and *New York* to that of the *Minneapolis*, as already stated, we get the following table :

Name of vessel... ...	Minneapolis.	New York.	Olympia.
Trial displacement...	7,387.5	8,480	5,586
Length on L. W. L...	411.6	380.0	340.0
Beam............	58.2	64.25	53.05
Mean draught........	22.5	23.9	20.73
Block coefficient......	0.478	0.509	0.517
Trial speed...........	23.07	21.00	21.686
" I H.P. (main engine)...........	20,366.2	16,947.8	16,849.83
Reduced displacement	5,586	5,586	5,586
Reduced speed.......	22.00	19.60	21.686
" I.H.P.......	14,750	10,400	16,849.8
I.H.P. for 22.00 knots at reduced displacement	14,750	16,500	17,847
Percentage of gain in economy of propulsion of triple screws over twin screws..	....	11.9	21.00

* Paper read before the Society of Naval Architects and Marine Engineers. Copyrighted.

When such a gain as this is shown, the most natural thing is to search for the cause, and here we are met with obstacles at the very start. Probably, after some consideration, the first suggestion would be that the center screw is very favorably placed for securing whatever benefit there may be from working in the forward current of the frictional wake. This would doubtless be accepted but for the fact that most of the authorities on screw propulsion have stated that while the screw itself would be helped, any gain in this direction would be offset by the increased resistance of the vessel due to the action of the screw interfering with the stream line action. It should be said, however, that most of the authorities simply state this as a proposition, without attempting any demonstration or quoting experimental data to confirm the statement. I am inclined to believe that this statement has been based on Froude's classic experiments on the *Greyhound*, and it is hardly necessary to remind this Society that, while the experiments themselves were admirable in every way, the *Greyhound* had a very poor model compared with modern steamers, and her machinery also was much different from that we now use. As a result, the data of the *Greyhound* experiments are of very little use as a guide for modern hulls and machinery. For example, Froude gave as a result of his experiments that the effective H.P., or power actually applied to overcome the resistance of the hull was only from 37 to 40 per cent. of the I.H.P. of the engines. About 10 years or so ago the late Mr. William Denny quoted a case where a comparison of the I.H.P. with the effective H.P. as determined by model experiments made by the younger Froude had shown the ratio to have risen to 60 per cent., and some calculations that I have had made for some of our new ships has shown the ratio to be, in some cases, nearly 75 per cent. I feel, therefore, that we should not let our admiration for Mr. Froude's great reputation lead to the unqualified acceptance of statements based on his experiments on the *Greyhound*.

Another objection, also, comes from the fact that there has gradually grown up a belief that propulsion by twin screws is more economical than by a single screw. This belief, I think, is based to a great extent on the admirable paper reau by my friend, Dr. White, the Director of Naval Constructiop of the British Navy ,before the Institution of Naval Architects in April, 1878, where he showed that a comparison of some single and twin-screw ships of the British Navy indicated a decided economy in propulsion by twin screws. I give below a table from his article * simply to call attention to the fact that a part of the reason for the increased economy of twin screws may have been due to their smaller diameter and greater helicoidal area. It will be observed at once that the slip of the single screws is very much greater than that of the twin screws, and by calculating the indicated thrust per square foot of helicoidal area it will be found that it is nearly twice as great for the single screws as for the twins. We are accustomed to allowing more indicated thrust for small, quick-running propellers than for large, slow-moving ones; but here the conditions are reversed. It is to be noted also that the speed of tips of the single screws is about 17 per cent. greater than that of the twins, which would make the resistance per square foot nearly 40 per cent. greater.

Whatever may have been the cause of the marked superiority of the twin-screw ships over those with single screws, it is to be noted that there are numerous instances of single-screw ships in which the I.H.P. per square foot of wetted surface is less than for the war vessels quoted by Dr. White. For example, the steamship *Charles V.*, built by Messrs. A. & J. Inglis, has an immersed surface of about 15,180 sq. ft. She is 323 ft. on L.W.L. by 33 ft. 9 in. beam, and on trial had a mean draft of 14 ft. 10 in., giving a displacement of 2,478 tons. At 14 knots the I.H.P. was 1,575, or 0.104 I.H.P. per square foot of wetted surface. Another vessel, the *Rotomahana*, has 13,650 sq. ft. of wetted surface, and is 285 ft. × 35 ft. 2 in. × 15 ft. 7¾ in., displacing 2,543 tons. At 14 knots the I.H.P. is 1,925, or 0.141 I.H.P. per square foot of wetted surface.

It may be objected that these vessels are much smaller than the war vessels, and also that the ratio of wetted surface to displacement is higher, thus giving a larger divisor. Data are available, however, of the performances of some larger merchant ships. Thus the *Umbria* and *Etruria* have 43,980 sq. ft. of wetted surface, 13,300 tons displacement, and are 500 ft. × 57 ft. 6 in. × 26 ft. 6 in. At 14 knots the I.H.P. per square foot of wetted surface is 0.121. In the case of the *Oregon*, the ratio was 0.118; in the *Servia*, 0.119, and in the *Gallia*, 0.127.

These cases all go to show that, so far as a comparison based on I.H.P. per square foot of wetted surface is concerned, the single-screw vessels made an even better showing than those with twin screws whose performances have been quoted. The *New York* and the *Olympia*, however, make a better showing than the older twin-screw vessels, giving, at 14 knots, the *New York* 0.115 I.H.P. and the *Olympia* 0.146 I.H.P. per square foot of wetted surface, or about the same as the single-screw merchantmen.

The facts thus stated would seem to leave it at least an open question whether the increased economy of the triple screws is not due to the center screw working in the wake, but there are others which make it seem the probable solution. When the *Columbia* was designed there was a general belief that the race from the side screws would cause the center screw to work in water having a sternward motion, and it was the intention to give it about 10 per cent. more pitch than the side screws. However, before the *Columbia* was tried, it was learned that the trials of the *Kaiserin Augusta*, the German triple-screw vessel, had shown that, if given such an increase of pitch, the center screw could not work up to the designed number of revolutions. When the *Columbia* was tried, all the screws were given the same pitch (21 ft. 6 in.), but the center screw ran some five revolutions per minute slower than the side screws, and the mean effective pressure of its engine reduced to the low-pressure cylinder was nearly 3 lbs. more than that of one of the side screws. In the case of the *Minneapolis*, the pitch of the center screw was set at 6 in. less than that of the side screws (21 ft. 6 in. and 22 ft.), and ran about one revolution faster than they with an aggregate mean effective pressure greater by 3 lbs. and nearly 700 more I.H.P. Now, clearly, this can only be explained by assuming that the forward wake exerts a very strong pressure, and, as we have the undoubted facts of the high-speed and moderate H.P., the action of the screw cannot have interfered with the stream in action enough to increase the resistance of the ship.

Thus, it seems to me, that the most reasonable explanation of the increased economy of propulsion is that, in an unusual degree, the center screw, which occupies the same position as the propeller in single-screw vessels, profits by the forward motion of the frictional wake, and this without interfering with the stream line motion sufficiently to increase the vessel's resistance.

In discussing this question of the greater efficiency of triple screws with some friends, it was suggested that possibly it was not entirely fair to compare the performances by Froude's Law, because the *Minneapolis* is longer than the *New York* and the *Olympia*, and, therefore, better adapted to high speeds, as the wave-making resistance would be less proportionally than for the shorter ships. While I did not believe that any difference due to this cause could account for the material difference which exists, I thought the suggestion worthy of examination, and so have had one of my assistants calculate the power required to tow each ship at the speed she actually made on trial, dividing it into skin-friction and wave-making resistance, using the formulæ and constants given in the recent work of my friend, Naval Constructor Taylor, entitled "Resistance of Ships and Screw Propulsion."

These calculations take cognizance of the slight variation in the coefficient of skin friction, due to the difference in length, as well as the influence upon the wave-making resistance of the relation between length and displacement. The power thus found is the useful work done in propulsion, and its ratio to the H.P. of the engines may be called the efficiency of propulsion.

It may still be objected that the comparison should be between the useful work and the power delivered to the propeller shaft, but, in addition to the trouble of making the calculation, it is to be considered that we are comparing the systems, including the engines, and that if, on the one hand, it be thought that the *New York* is at a disadvantage on account of having four engines, the *Olympia*, on the same line of reasoning, would be at an advantage as having only two.

The formulæ used are:

For skin-friction resistance, $R_f = f.\ S.\ V^{1.83}$, where

f = coefficient of skin friction from Taylor's tables.
S = wetted surface.
V = speed in knots per hour.

For wave-making resistance, $R_w = b_o \dfrac{D^{\frac{2}{3}}}{L} V^4$, where

b_o = coefficient taken from Taylor's data.
D = displacement in tons.
L = length on load water line in feet.
V = speed in knots.

* Table omitted from this report.

LOCOMOTIVE RETURNS FOR THE MONTH OF AUGUST, 1894.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	864	787	....	....	....	1,959,214	2,489	....	....	....	....	....	84.33	....	....	4.36	8.33	0.44	....	6.74	1.57	21.44	....	....	1.90
Canadian Pacific	607	....	512,189	605,786	445,873	1,563,858	....	....	....	....	....	....	64.36	....	....	2.88	9.44	0.29	....	5.68	1.14	19.43	....	1.76	2.96
Chic., Burlington & Quincy	....	541	....	....	....	1,463,777	2,706	5.17	20.24	....	....	....	88.41	....	....	3.49	5.47	0.20	0.12	7.02	....	16.30	....	....	1.36
Chic., Milwaukee & St. Paul	....	854	....	....	....	2,295,192	2,686	....	....	....	....	....	63.21	....	....	3.29	6.59	0.25	....	6.88	....	17.01	....	....	2.10
Chic., Rock Island & Pacific	563	....	500,441	853,189	304,453	1,658,083	2,946	5.50	19.20	....	....	....	90.14	9.67	4.12	3.01	5.83	0.22	....	6.02	0.37	15.45	....	....	1.68
Chicago & Northwestern	1010	....	836,019	1,361,894	699,077	2,896,990	2,868	....	....	....	....	....	75.30	....	....	3.03	8.71	0.27	....	7.14	....	19.15	....	....	2.31
Cincinnati Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cumberland & Penn.*	....	23	6,421	40,609	....	47,030	2,045	....	....	....	....	....	83.13	....	....	5.67	4.49	0.34	....	....	1.49	11.99	....	....	....
Delaware, Lackawanna & W. Main L.	213	192	70,820	193,285	380,222	644,327	3,355	....	....	....	....	....	79.79	....	....	2.94	6.04	0.42	....	5.82	....	15.22	....	....	1.50
Morris & Essex Division	162	....	188,434	145,600	75,707	418,741	2,584	....	....	....	....	....	58.41	....	....	4.51	9.17	0.36	....	6.91	....	20.95	....	....	3.11
Flint & Père Marquette	....	84	93,799	66,154	53,620	213,573	2,542	....	....	51.77	79.76	50.46	60.95	....	....	2.76	5.76	1.14	....	5.01	0.98	14.60	....	....	1.80
Hannibal & St. Joseph	....	69	67,639	131,942	36,555	236,136	3,578	5.11	17.92	....	....	....	76.69	13.38	5.74	2.27	5.46	0.11	0.23	6.67	0.04	14.78	....	....	1.44
Kansas City, Ft. S. & Memphis	140	....	95,753	168,814	74,491	339,058	2,898	....	....	....	....	....	60.82	....	....	3.44	4.39	0.35	0.47	7.34	....	15.99	....	....	1.38
Kan. City, Mem. & Birm	42	37	24,120	52,765	14,948	101,833	2,752	....	....	....	....	....	65.22	....	....	3.58	2.81	0.29	0.30	6.76	....	13.74	....	....	0.87
Kan. City, St. Jo. & Council Bluffs	....	17	49,798	41,003	40,320	131,121	3,642	5.15	22.81	....	....	....	60.16	12.14	4.41	3.04	5.59	0.18	0.40	6.69	0.03	15.88	....	....	1.70
Lake Shore & Mich. Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Louisville & Nashville	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Manhattan Elevated	....	280	710,711	....	64,068	774,779	2,763	....	....	....	....	....	34.09	....	....	2.20	6.90	0.20	0.40	9.50	....	19.20	....	....	4.05
Mexican Central	148	133	....	....	....	458,594	3,447	....	....	....	....	....	66.88	....	....	4.81	12.94	0.43	0.13	4.86	....	23.17	....	....	3.82
Minn., St. Paul & Sault Ste. Marie	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Missouri Pacific	....	351	....	....	....	945,248	3,316	4.38	17.11	....	....	....	73.22	....	....	5.49	5.24	0.30	1.63	6.36	1.28	20.30	4.27	1.39	1.41
Mobile & Ohio	105	80	63,941	137,616	54,134	256,691	....	....	....	....	....	....	61.73	....	....	2.79	3.95	0.22	0.64	5.58	1.02	14.20	....	....	1.28
N. O. and Northeastern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
N. Y., Lake Erie & Western	629	....	463,905	759,804	243,749	1,467,458	2,828	4.80	16.80	87.10	127.90	....	94.10	18.20	5.30	4.13	7.26	0.34	1.84	7.36	1.22	22.15	....	....	1.39
N. Y., N. H. & H., Old Colony Div	....	....	445,688	157,498	152,011	755,197	3,558	4.10	16.90	....	....	....	61.69	14.80	4.70	2.92	8.53	0.54	....	6.90	0.55	19.44	....	....	...
N. Y., Pennsylvania & Ohio	278	....	137,291	394,913	153,567	685,771	3,209	6.20	19.30	75.40	113.70	....	91.05	12.20	5.90	2.56	5.32	0.29	1.67	7.02	0.99	17.85	....	....	1.07
Norfolk & Western, Gen. East. Div.†	....	40	107,819	374,836	60,149	542,804	2,762	5.24	16.37	62.00	120.00	....	109.31	13.37	7.62	9.14	3.78	0.24	....	....	....	13.16	....	....	....
General Western Division†	....	....	100,132	341,202	53,953	485,287	2,984	5.60	20.71	44.44	118.12	....	63.75	7.92	5.46	6.62	3.26	0.27	....	....	....	10.15	....	....	....
Ohio and Mississippi	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Philadelphia & Reading	....	....	471,939	330,529	882,883	1,685,351	....	....	....	....	....	....	57.51	....	....	4.80	4.50	0.34	....	5.82	0.42	15.88	....	....	....
Southern Pacific, Pacific System	723	648	651,193	1,102,996	279,601	2,033,790	3,138	5.35	13.87	....	....	....	71.28	....	....	4.60	17.96	0.19	1.95	7.58	1.04	33.32	....	....	4.75
Union Pacific	....	440	457,671	781,607	207,193	1,446,461	3,287	6.16	19.85	....	....	....	84.78	....	....	6.42	8.83	0.40	....	7.67	1.03	24.35	3.90	1.55	1.85
Wabash	418	354	438,537	732,697	235,711	1,406,945	3,974	4.83	16.37	....	....	....	80.22	....	....	3.35	4.71	0.31	....	5 67	0.77	14.81	2.74	1.01	1.11
Wisconsin Central	149	110	148,317	175,720	90,014	414,051	3,764	....	....	....	....	....	69.11	....	....	2.22	6.77	0.15	....	6.67	....	15.81	....	....	1.94

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs, and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

We then get the following table :

	Speed knots.	Skin friction resistance. Lbs.	Wave-making resistance. Lbs.	Total resistance. Lbs.	I.H.P. for useful work.	I.H.P. on trial.	Percentage of efficiency.
Minneapolis...	23.07	82,030	104,420	186,450	13,790	20,366	67.72
New York.....	21.00	73.880	85,360	159,240	10,268	16,947	60.59
Olympia.......	21.69	61,375	82,150	143,525	9,560	16,850	56.73

The increased efficiency of the triple screws over twins is thus, in the case of the *New York*, 11.8 per cent., and in the case of the *Olympia*, 19.38 per cent.

In comparisons such as we have been making, a very important matter must not be overlooked—the standardization of the indicators and the correction of the mean pressures for the errors found. Since the trial of the *Yorktown*, in February, 1889, the first case in which the indicator errors were considered, nearly a thousand tests of indicators have been made and reported to the bureau of which I am chief, and we have found that indicators submitted as first-class have, in many cases, shown errors so great that allowance for them would reduce the mean pressure as much as 10 per cent. Until recently it was assumed that the indicators were correct, so that it may have happened that differences in H.P., on which serious arguments were based, were not real, but due to one set of indicator springs having a very large error.

In the comparison of the performances of the *New York* and the triple-screw ships, I feel assured that we do not run this risk, as the indicators in each case were tested by the same officer, who is probably the best expert at such work in the country, the errors were in every case moderate, and the mean pressures were in all cases corrected. The indicators of the *Olympia* were also standardized, but by another officer, and by a slightly different method. I believe her H.P. is substantially accurate, but it is not comparable with the others with the same strictness as they are with each other.

As has already been stated, it was not anticipated, when triple screws were adopted, that their use would give any increase of economy of propulsion, their adoption being due mainly to constructive reasons, and incidentally to secure economy at cruising speeds. It appears now, however, that this method does give an increase of economy at maximum powers. It would seem, therefore, that, for very high-speed ships, this arrangement would commend itself, and, if it were not dangerous to prophesy, I should be prepared to anticipate the adoption of triple screws for all the new "flyers" that enter for the transatlantic race. In this connection the closing remarks of Dr. White, in the paper already referred to, are highly interesting, and it would seem that, by substituting triple for twin screws, and *Minneapolis* for *Iris* his remarks would apply now. They are as follows :

"Looking to the future of steam navigation, one thing seems certain—greater speeds will be attained than are now reached. It does not seem probable that any considerable increase in fineness of form, or in the ratio of length to breadth, will be adopted in future ships for the purpose of diminishing their resistance. Any increase in the load-draughts is also clearly inadmissible. The greater engine powers which will probably be used in the swifter ships will consequently have to be applied on a limited draft of water ; and hence it may be anticipated that at no very distant date the designs of swift mail steamers will be subject to conditions resembling those sketched above for the *Iris*. The extreme draft will not permit a use of the single screw with a disk area bearing anything like the ordinary ratio to the I.H.P. ; and it will become necessary either to depart from established precedents in the ratio of pitch to diameter of single screws, to adopt twin screws, or to accept greater speeds of pistons and propellers than are now common in large marine engines. At the present moment there is no great urgency in deciding between these rival methods, and I have no wish to attempt a prediction as to the practice of the future. The matter is, however, one well deserving the careful consideration of marine engineers and naval architects."

A few words more and I shall finish. It would be a natural supposition that, having built the two fastest cruisers in the world for our Navy, every naval officer would rejoice at their possession and be proud of them. I regret to learn, however, that we are in a mild way repeating the experience of the *Wampanoag*, which, as some of you may remember, was declared a failure by a board of naval officers, although she was far and away the fastest vessel in the world, being several knots faster than anything else afloat, and, as some believe, an important factor in the settlement of the Alabama claims at Geneva. Now the cry is raised that, although we have the fastest ships, they cannot carry coal enough to go across the ocean at full speed. In fact, some say that we don't want such fast ships ; and others, echoing the jealous wails of a few of our transatlantic friends, have actually talked about the ships being failures.

It seems very hard to satisfy our critics. Before we began the building of our new Navy it was constantly hurled in our teeth that we were behind the times ; that we couldn't build as good ships as they did abroad, and so on to the end of the chapter. Now we have beaten our foreign friends, and we are told that fast ships are useless. It seems to me that the idea so cleverly put by my friend, Nixon, of Cramp's, in regard to battle ships is equally true of fast cruisers. Explaining why we should not rely on monitors alone, he said : "You can't get as much fight out of two million dollars as out of five." So it is with these fast cruisers. We don't want our Navy to consist of them alone, and, as I said here last year, I believe, for mere peace cruisers, we have overspeeded many of our ships ; but in time of war I believe there is a great field for just such ships as our triple-screw cruisers—the fastest vessels now afloat.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in October, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN OCTOBER.

Toledo, O., October 1.—Train wreckers succeeded in wrecking a passenger train on the Wabash Railroad at Maumee, 12 miles south of here to-day. F. N. Smith, engineer, was killed, and A. H. Day, fireman, fatally hurt.

Buffalo, N. Y., October 1.—Charles Avery, an engineer on the Lehigh Valley Railroad, had his foot crushed between a draw-head of an engine and a flat car to-day.

Benson, Ariz., October 1.—E. G. Roesler, an engineer, was seriously scalded by the bursting of a flue on an engine of the Mexico & Arizona Railroad, and died of his injuries.

St. Joseph, Mo., October 1.—A passenger train on the Atchison, Topeka & Santa Fé Railroad collided with a freight train on the Kansas City, St. Joseph & Council Bluffs Railroad south of here, as a result of disobedience of train orders by the freight. C. E. Page, engineer on the passenger train, had his leg broken and was internally injured.

San Francisco, Cal., October 2.—Martin Ford, an engineer on the Southern Pacific Railway, was caught between cars, and had his pelvis crushed ; he is in a precarious condition.

Baraboo, Wis., October 2.—A cattle train on the Chicago & Northwestern Railway ran into a freight train at Lavalle this morning. Engineer Sullivan received severe injuries.

Leavenworth, Kan., October 2.—A special passenger train on the Missouri Pacific Railroad ran into an open switch at South Leavenworth to-day. Engineer Alix McCambridge jumped, and was severely cut about the face. Fireman Lee Blanchard also jumped, and sustained injuries of the arm.

Laredo, Tex., October 2.—A wreck occurred on the Mexican National Railway near Monterey to-day. A double-header freight train struck a cow, ditching both engines. Engineer Dan Drennan was killed outright, and Engineer Joe Sharp was scalded, from the effects of which he died in the evening.

Wakefield, Mass., October 4.—An extra passenger train on the Boston & Maine Railroad ran into a freight train at this point to-day at noon. The engineer and fireman of the extra were badly injured.

Smithfield, Mo., October 4.—An engine and 12 cars on the Union Pacific Railroad jumped the track at this point. Engineer Mike Ketchum and Fireman Tom Warren were instantly killed.

Bristol, Tenn., October 7.—A train wrecker put a bolt on a rail on the Southern Railway near here to-day, causing an express train to jump the track. Samuel Smith, engineer, had his leg broken, was scalded, and was buried under the wrecked train, and will probably die from his injuries. Will Holmes, fireman, had his head cut and was badly scalded.

Tomahawk, Wis., October 8.—Train wreckers sawed the timber supporting the Sou Line Railway bridge at Tomahawk, and wrecked the west-bound passenger train. The engine plunged into the river, and the body of the fireman is buried beneath the engine. The engineer had both his legs broken.

Rochester, N. Y., October 8.—In a collision between two freight trains on the New York Central & Hudson River Railway at Walworth to-day, Fireman George Soulier sustained fractures of three ribs and was otherwise injured.

Memphis, Tenn., October 8.—A fast mail train on the Louisville & Nashville Railroad was wrecked at a siding 67 miles from here to-day. Engineer Joseph Lewis and Fireman James Burnes were seriously injured.

Clinton, Ia., October 8.—Engineer John Haley jumped from his engine at La Force this morning, thinking that a collision with a train on a siding was inevitable; he struck a switch and was torn almost in two.

Seymour, Ia., October 8.—A freight train on the Chicago, Rock Island & Pacific Railroad jumped the track at Sleepy Hollow this morning. Engineer Gerald Nolan and Fireman Marshall Lowe were instantly killed.

Pittsburgh, Pa., October 9.—Fireman Frank George was instantly killed on the West Penn Railroad by being struck by a passing train.

Flagstaff, Ariz., October 9.—A passenger train on the Atchison, Topeka & Santa Fé Railroad ran into a steer 50 miles east of here to-day. The engineer and fireman were slightly hurt.

Asheville, N. C., October 9.—A freight train on the Asheville & Spartanburg Railroad ran away down a heavy grade on the Salada Mountain this morning; the train was wrecked at the bottom, and Fireman York was buried under the wreckage and killed.

Shreveport, La., October 10.—A freight train on the Texas & Pacific Railway ran into some loaded cars near here to-day. The engineer had his leg broken, and was scalded about the head and face; Fireman Tom Hurndon had one hip dislocated and both legs broken.

Brooklyn, N. Y., October 10.—Frank E. Grady, a fireman on the Brooklyn Elevated Railroad, while at work slushing the front end of his engine, was thrown from his position and jammed between the wheels of the engine and a girder by the side of the track. His left leg was entirely severed and his body was frightfully crushed.

The Dalles, Ore., October 12.—A passenger train on the Oregon Railway & Navigation Company's Line was wrecked near here to-day. The fireman and engineer were seriously injured.

Montclair, N. J., October 12.—A boiler exploded on the Delaware, Lackawanna & Western Railroad at this point today. The fireman was killed and the engineer fatally injured.

Springfield, Ill., October 12.—A train wrecker drove a coupling pin into a frog in a switch of the Wabash Railroad at Rivington, wrecking the passenger train. Engineer Stewart and William Jones are badly injured.

Chicago, Ill., October 12.—John Haley, an engineer on the Chicago & Northwestern Railroad, jumped from his engine to-day, when it ran over a man, and was killed.

Newbern, N. C., October 16.—A freight train on the Chesapeake, Ohio & Southwestern Railway was wrecked 2 miles west of here this morning. Engineer McCaine and Fireman Kilcoyne were dangerously injured. The wreck was caused by train wreckers placing ties across the trestle.

Richmond, Va., October 18.—A collision occurred in the yards of the Richmond, Fredericksburg & Potomac Railroad near Acker Station to-day. Engineer John S. C. Eastman was seriously injured, as was also Engineer Bryant.

Fall River, Mass., October 19.—A collision occurred on the New York, New Haven & Hartford Railroad this morning at Drownville. Two firemen were hurt, one having his ankle broken.

Philadelphia, Pa., October 20.—A passenger train on the Philadelphia, Wilmington & Baltimore Railroad ran into a freight train at Glen Mills to-day. Engineer Rambo jumped from his engine, and was slightly hurt.

Wheeling, W. Va., October 20.—A fast express train jumped the track at Willard Tunnel early this morning. Engineer Cummins and Fireman Owings were seriously hurt.

Cumberland, Md., October 20.—Charles F. Fredericks, an engineer on the West Virginia Central Railroad, was killed here this morning by being caught between two trains.

New Orleans, La., October 20.—A freight train on the Illinois Central Railroad jumped the track near Calhoun Station, Miss., this morning; Engineer Cotton had his wrist dislocated.

Kansas City, Mo., October 21.—A freight train on the Union Pacific Railway ran into an open switch to-night and plunged down a 15-ft. embankment. The engine men jumped and were slightly injured.

Delaware, O., October 22.—A parallel rod on a pushing engine on the Columbus, Hocking Valley & Toledo Railroad was broken here to-day. The engineer, on reversing the engine, broke the other bar; he is badly injured and suffers from a dislocated knee-cap.

San Antonio, Tex., October 22.—A collision occurred between a passenger and stock train on the Southern Pacific Railroad near Walker to-night. Con Connors, the engineer of the freight, had both legs broken, and will probably die; Carl Hunsacker, fireman of the freight, was less badly injured about the legs.

New York, N. Y., October 22.—George Chase, an engineer on the New York, New Haven & Hartford Railroad, was fatally scalded this afternoon by the bursting of a steam pipe at New Rochelle; the fireman was also scalded, but not so severely.

Camden, O., October 22.—Robert Hodgin, Jr., a fireman on the Cleveland, Cincinnati, Chicago & St. Louis Railroad, was seriously injured by being struck by a water-tank pipe at Barnet's Station, 2 miles north of here to-day.

Boston, Mass., October 24.—A misplaced switch in the yard of the New York, New Haven & Hartford Railroad was the cause of a collision between two trains to-day. Engineer Nicols was hurt about the arms, and Engineer Winchenbach was somewhat injured.

Olathe, Kan., October 24.—A freight train on the Kansas City, Fort Scott & Memphis Railroad ran into an empty box car that had blown on to the main line from a side track. Fireman Lincoln Stewart was killed by being buried under the ruins. Engineer Smith jumped, and was severely injured by dislocating the left shoulder and receiving internal injuries.

Atlanta, Ga., October 26.—An engine and 30 cars on the Macon & Northern Railroad went through a burning trestle this morning. Engineer Gay was instantly killed by being scalded to death.

Bristol, Pa., October 28.—A fast freight train on the Pennsylvania Railroad crashed into the rear end of a work train at Croyden Station this morning. The engineer of the freight, Ed. Stow, jumped from his engine, and sustained a scalp wound and severe contusion of the body; Henry Kenney, fireman of the construction engine, had his shoulder fractured.

Boston, Mass., October 28.—An engine on the Boston & Maine Railroad suddenly left the rails and capsized on an embankment near Orient Heights this morning. Engineer Peter Hanson was internally injured.

Lima, O., October 29.—A fast freight on the Pittsburgh, Fort Wayne & Chicago Railroad was run into at the rear east of Ottowa Bridge to-day. Engineer John Koehler and Fireman E. D. Rhoades were severely injured, but not seriously.

Scranton, Pa., October 30.—An express train on the Delaware, Lackawanna & Western Railway ran into an open switch near here to-day, and collided with the rear end of a coal train. Engineer Lynott was instantly killed, and Fireman Elmer Scull received fatal injuries. On the passenger train, Valentine Butler, the engineer, escaped with a few bruises; Fireman Hosey was caught in the wreck of the engines and scalded to death.

Our report for October, it will be seen, includes 44 accidents, in which 13 engineers and 11 firemen were killed, and 28 engineers and 20 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosion	1
Broken side rod	1
Burned trestle	1
Cars blown on track	2
Cattle on track	2
Caught between cars	2
Caught between engine and cars	1
Collisions	10
Derailments	6
Flue bursting	2
Jumping from engine	2
Misplaced switch	4
Runaway train	1
Run over	1
Struck by obstruction	1
Thrown from engine	1
Train wreckers	5
Unknown	1
Total	44

WATER-TUBE BOILERS AND THEIR APPLICATION TO WAR VESSELS.*

By J. Nastoupil.

Water-tube boilers are boilers wherein the water to be evaporated is contained in tubes whose walls are in direct contact with the gases of combustion, and therefore form the heating surfaces of the boiler. As the water contained in the tubes is heated it rises into the space above, causing a circulation in the boiler. While the warm and specifically lighter water rises into the water space above an equal amount of cooler and specifically heavier water descends.

Such a circulation is shown in fig. 1, where the heated water rises at *B*, while the cooler water flows back through *C*. The rapidity of the circulation can be increased by introducing the feed-water at *D*. The case often occurs that the water in one part is lighter, because it is a mixture of steam and water, as represented by fig. 2, and the hydrostatic law seems at fault, for it is independent of the hydrostatic pressure on the cross-section; so the circulation of the water will be maintained by the generation and the movement of the steam.

A strong and regular circulation of the water is an essential feature for the proper action of water-tube boilers. It protects the tubes, which are subjected to high temperatures, from burning, it equalizes the temperature and the expansion of the whole boiler structure, and the result is that the generation of steam is raised to the highest possible point. The circulation of the water ought not to be injured through the choice of the sectional area of the tubes. The higher the temperature and the greater the corresponding length of the tubes, just so much the larger must the cross-section of the same be made, otherwise the tube, on account of an insufficient circulation of water, will only deliver a stream of steam.

The form of boiler given in fig. 3 shows that if the sectional area of the tubes at *A* is sufficient for the circulation of the water, then that at *B*, where a higher temperature exists, will be insufficient. The result is that the tubes are overheated, and this has actually occurred in many miscalculated water-tube boilers. On the other hand, it is a further requirement from the standpoint of safety, that the sectional area of the tube should not exceed a certain amount in order that the average tubes can be run to advantage. It is upon these grounds that the diameters of water tubes for the different types of boilers used on vessels of war vary between the wide limits of 1 in. and 4 in., while the boilers for vessels engaged in commerce are usually fitted with tubes of the larger area.

The tubes that are used are, for the most part, seamless and of steel, but copper and brass are also employed. In long boilers with a forced-draft service wide variations of temperature are unavoidable in certain parts of a marine boiler, causing, especially in boilers of large diameters, marked expansions and contractions of the parts which form a frequently recurring source of leakages and damages. This is especially the case where the flame impinges against the fire-tubes. The recently adopted method of using ferrules as a protection for these joints is merely a palliative, as it has no metallic connection either with the tube or the tube-sheet, and, therefore, it soon becomes heated to a glowing temperature and burns away.

A similar attachment has also been applied to water-tube boilers, but with the difference that the tubes are subjected to an internal pressure, and that the connections must be placed in such a position that they are protected from the direct action of the flame.

As for the present construction of water-tube boilers, we find that we must thank the French engineers for the advances which they first made along these lines, for they have already made a successful application of boilers of this class to their vessels, and have led the navies of other nations in the application.

It is, of course, self-evident that special types of water-tube boilers must have been developed for the different types of vessels. Especial attention must necessarily be paid to their construction and their performance, in so far as they are to be adapted to particular services, and they must not be regarded solely from the standpoint of their general adaptability to all sorts of work. In order to specify two extreme cases, a boiler which would be thoroughly well fitted for application to a battleship would be of no use whatever on a torpedo-boat.

Viewed from this standpoint, it is possible to classify all of the water-tube boilers that have thus far been brought out into four groups, according to the location and shape of the tubes that are used. These groups are:

a. Water-tube boilers with straight and level tubes.—This group comprises the Perkins, Belleville, Palmer and Herreshoff boilers.

b. Water-tube boilers with straight and inclined tubes.—These are the Root, Watt, Belleville, Yarrow, Oriolle, Lagrafel D'Allest, Sampson, Durr, and Niclausse boilers.

c. Water-tube boilers with bent tubes.—Of such are the first Belleville boilers, the Rowan, Ward, Du Temple, Normand, Thorneycroft, Yarrow, Babcock & Wilcox, Wilson and Gleming & Ferguson boilers.

d. Water-tube boilers with spiral tubes.—These include the Herreshoff, Hohenstein, Bellis and White boilers.

As early as 1879 the French despatch boat *Le Voltigeur*, of 1,000 I.H.P., was fitted with Belleville boilers. After a satisfactory service of the boilers for a period of about three years no repairs were required. The French Admiralty has up to

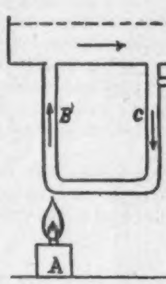


Fig. 1.

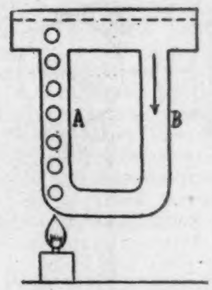


Fig. 2.

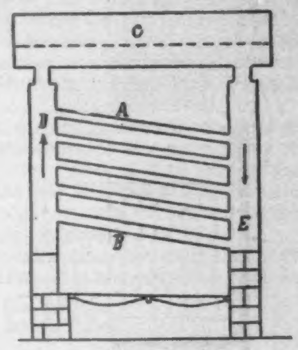


Fig. 3.

the present time applied the Belleville boiler to vessels of all sizes and kinds, including among the gunboats the *Crocodile*, of 450 I.H.P.; the *Active*, of 400 I.H.P.; the *Léger*, 2,200 I.H.P.; the *Lévrier*, 2,200 I.H.P.

It has also been applied to the cruisers *Milan*, 3,800 I.H.P.; *Alger*, 8,000 I.H.P.; *Hirondelle*, 2,100 I.H.P.; *Rigault de Genouilly*, 2,100 I.H.P.; *Latouche Treville*, 7,400 I.H.P.; *Chanzy*, 7,400 I.H.P.; *Charner*, 7,400 I.H.P.; *Bruix*, 8,500 I.H.P.; *Descartes*, 8,500 I.H.P.; *Pascal*, 8,500 I.H.P.; *Galilée*, 6,500 I.H.P.; *Catinat*, 9,000 I.H.P.

In addition to these it has been put upon the coast defense ship *Tréhouart*, of 7,500 I.H.P., and the battleships *Brennus* and *Bouvet*, of 14,000 I.H.P. each.

In the Russian Navy water-tube boilers of the Belleville type are used in the armored gunboats *Grozjasciji*, *Gremjasciji* and *Otvaznji*, of 2,000 I.H.P. each, also in the royal yachts *Marevo*, of 200 I.H.P., *Standart*, 15,000 I.H.P. and *Czarevna*, 800 I.H.P., as well as in the armored cruiser *Minin*, of 6,000 I.H.P.

In the English Navy the Belleville boiler has proven itself satisfactory in the *Sharpshooter*, of 3,500 I.H.P., and it has also been applied in the new first-class cruisers *Powerful* and *Terrible*, of 25,000 I.H.P. each.

Referring to the merchant marine, we find that as long ago as 1871 the Lagrafel boiler was used in the steamer *Isère*, and the same type of boiler was applied to the steamers *Blidah* and *Medea* in 1873, remaining installed in these vessels up to the present day.

In 1874 Lagrafel boilers were set in the steamers *Paoli* and *Saphis*, remaining in service until the sinking of these ships at the end of seven and eleven years, respectively. These same boilers were applied to the steamships *Colon*, *Cabile* and *Caid* in 1874, 1875 and 1876, respectively, and remained in service for many years.

The steamer *Liban*, built in 1882, was rebuilt in 1891, and had Lagrafel D'Allest boilers put in her. The *Dom Pedro* was reconstructed in the same way; the first of these being engaged as a general tramp, while the latter made regular trips between Europe and South America.

In 1884 the steamer *Ortegal*, of 1,800 I.H.P., belonging to the Messageries-Martimes Co., was fitted with compound engines and the Belleville boilers. The steamer *Sindh* (2,400 I.H.P.), belonging to the same company, had had a new set of boilers of the same kind put in her many years previously.

* Paper read before the Wissenschaftlichen Verein der k. und k. Kriegsmarine.

The same type of water-tube boilers have been put in the newest and largest ships of this same company—namely, the *Australien, Polynesien, Armand Behic, Ville de la Ciotat*, of 7,000 I.H.P. each, and the *Ernest Simons*, of 5,600 I.H.P.

The steamer *Mitidjah* is fitted with the Oriolle boiler.

The English steamer *Nero*, belonging to F. Willson & Sons, of Hull, has the Babcock & Wilcox boiler.

The *Friant, Charles Martel* and *Elan*, of the French Navy, as well as several steam yachts, have the Niclausse type of boiler.

The White water-tube boiler has also given satisfactory results in an English vedette boat.

DESCRIPTION OF SOME TYPES OF WATER-TUBE BOILERS.

I. The Babcock & Wilcox boiler, as it is built by the firm of the same name in New York and Glasgow, is shown in figs. 4–6, and is the type of boiler used on the steamship *Nero*.

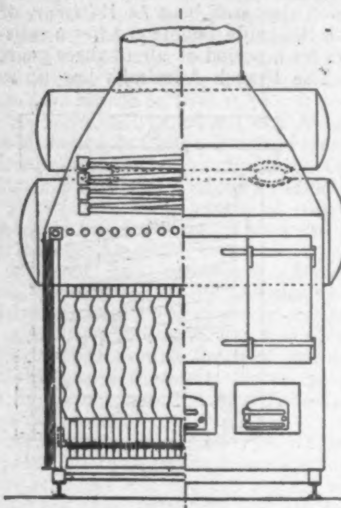


Fig. 4.

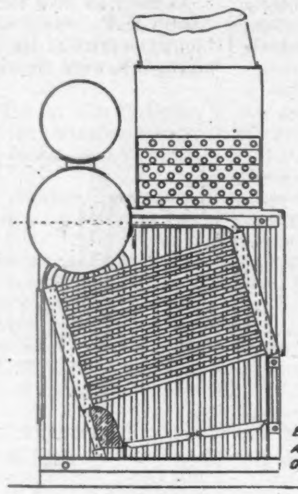


Fig. 5.

Fig. 6.

THE BABCOCK & WILCOX BOILER.

In this case the working pressure is 200 lbs. per square inch, yet the construction is so substantial, as far as strength sufficient for safety is concerned, that there is nothing to prevent the construction of boilers of this type capable of working under a still higher pressure.

The boiler is constructed of two different nests of tubes, in which a separate circulation of water is maintained. One of these nests of tubes is located directly over the grates, and is a modification of the water-tube boiler made by the same firm for stationary purposes. It consists of a number of pairs of front tubes of sinuous shape, which are connected with each other by means of separate groups of tubes, as the lower portion of figs. 1–4 would indicate. These groups of tubes of four each can be readily removed through the hand-holes. The stationary boilers of this make have, instead of a group of tubes, a single tube of a somewhat larger sectional area.

Over this nest of tubes, and like unto the outer shell of a boiler, there lie two cylindrical steam chambers, of which the upper one contains steam only when the boiler is in service, while the lower one is half filled with water and steam.

All of the front tubes open with free communication into the lower steam chamber, while those at the back communicate at their lower end with a common mud drum, which is fitted with a blow-off cock. While the boiler is in service the water flows through the inclined tubes and enters as a mixture of steam and water into the front tubes, and is delivered by them into the upper connecting pipes into the lower steam chamber, where the water and steam separate. In like manner there is an outflow of cooler water from this lower steam chamber or drum into the tubes at the back.

The second system of tubes consists especially of a number of vertical tubes, which likewise form a portion of the collateral boiler arrangements. The lower ends of these tubes are fastened into two four-cornered horizontal tubes, while their upper ends either run directly into the lower steam drum, but always below the normal water-level, or open into two other horizontal tubes, which are in turn led into the same steam drum, but always below the normal water-level. The water circulation in this system of tubes is such, that the water which is heated in the vertical tubes rises and flows into the steam drum, either directly or through the intermediary of the upper horizontal tube, while it leaves the drum through three or four tubes at the back of an equivalent sectional area.

At the front of the boiler there is still another tube which forms a part of the boiler framing, and is connected with this latter system of circulation. Over the boiler at the base of the stack a tubular heater is placed. This consists on one end of five and on the other of four end tubes, which are connected with each other by an equal number of straight tubes, wherein the water, which is delivered from the feed-pump, enters into the lower end tube or header at one end and flows through the connecting tubes to the other side, and thence back and forth till it enters the upper header, from which it is delivered into the boiler. In this header the water circulation is entirely mechanical or forced, and depends upon the running of the feed-pump. The heating surface of the heater is usually

Fig. 7.

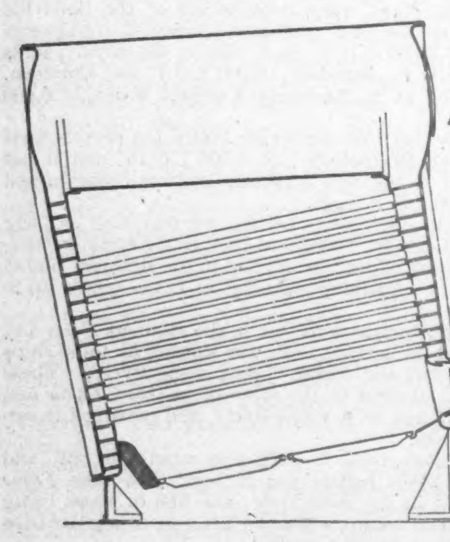


Fig. 8.

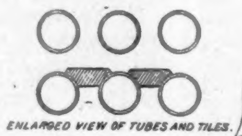
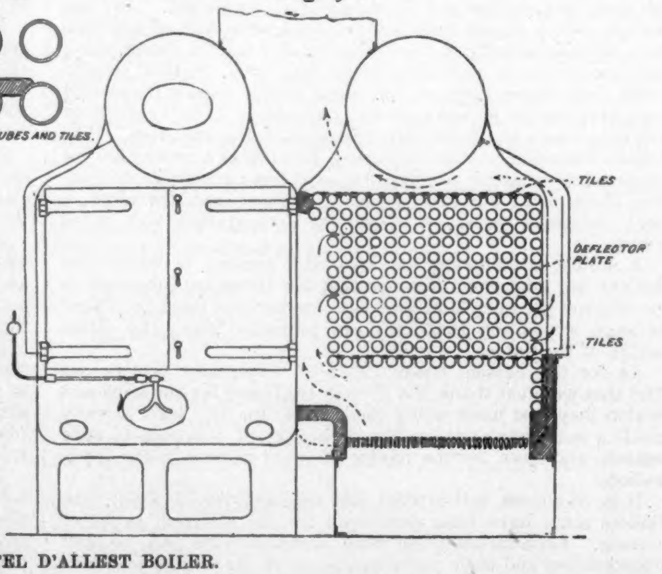


Fig. 9.



THE LAGRAFEL D'ALLEST BOILER.

one-sixth that of each of the boilers, and as it is the coolest part of the boiler, it is not to be supposed that the escaping products of combustion can be hot enough to raise this water up to the temperature of evaporation, so there is no generation of steam in the heater, but this first occurs in the boiler itself.

The tubes used in the nest that is located directly over the fire in this boiler have an internal diameter of 1⅛ in., and a length of 7 ft.; the side vertical tubes are 3 in. diameter, are spaced 5 in. apart from center to center, and are about 9 ft. long, while the tubes in the heater are 3 in. in diameter and are approximately 7 ft. 6 in. long. The side construction consists of 2 in. of strong mason work supporting the vertical tubes, and ½ in. of strong insulating material made of asbestos sheets bound together with lead cement.

The front and back consist principally of doors, which give access to the end tubes and their numerous hand-holes.

Three fire-doors are usually provided for the stoking. The grate surface is either one common surface, or is divided by fire-brick walls into three parts with a door for each part, an arrangement that permits of a more satisfactory handling of the fire.

A peculiarity of these boilers consists in the fact that the tube connections are simply rolled or expanded connections, and that no screwed stay tubes are used. By avoiding different thicknesses in the shells of the tubes, such a boiler will be protected from the strains that would result from variations of temperature and the consequent unequal expansion. The construction guarantees perfect tightness as well as strength for all ordinary services. The tubes of a square section are also connected to each other in a characteristic manner; it is done by round openings into which the tube body is fastened by rolling.

The hand-holes arranged for the rolling of the tubes must be so designed as to be closed by some simple device. Their caps are removed outwardly so that the pressure tends to push them off. The tightness of the cap is assured by the arrangement of the bearing surface without having recourse to a packing material. The strap on the boiler is held by bolts, it is made in one piece, and so formed that should a bolt break and the cap fall only a slight leak would be the result, and a great quantity of steam and water would not issue forth. The importance of such a detail in the construction is very important, when we consider that in a boiler of ordinary size there are more than a hundred of such caps.

II. The Lagrafel D'Allest boiler (figs. 7–9), as it is at present built by the firm known as the Forges et Chantiers de la Mediterrannée and the Fraissinet Company, of Marseilles, has a certain internal likeness to the Babcock & Wilcox boiler.

The boiler consists of two water legs, which are connected with each other by a number of inclined water tubes lying directly over the fire. These water legs are formed of two flat sheets which are held together by numerous stay-bolts, and they are closed at the bottom and sides, while at the upper ends they are open into a steam drum of cylindrical form.

In the construction of this boiler there are as many openings in each water leg as there are tubes, and the holes in the outer sheets are larger as the diameter of the tubes may demand. The tubes are fastened in the tube-sheets by rolling and expanding, which is done through the openings in the outer sheet. The openings in the outer sheets are closed by coverings whose lids lie inside the boiler, and which are held in position by bolts and yokes; the joints are made by asbestos and a soft copper wire. The boiler has no stay tubes; the water legs, which are connected at the top through the steam drum, need no further bracing at this point, and the connection of the remaining parts is effected by friction through the rolling out of the tubes in the tube-sheets.

The tubes that are ordinarily used have an inside diameter of about 2¾ in., a thickness of ⅛ in., and are spaced 4 in. from center to center. Servé tubes are used in the lower rows.

While in service the water-level is maintained so as to cover the bottom of the steam drum, and the circulation of water is kept up by the water, which is heated in the tubes, flowing out into the front water leg as a mixture of steam and water, and thence rising directly into the drum. The water that has thus arisen spreads out over the bottom of the drum and flows down through the back leg, from which it is received into the tubes.

The arrangement of the course of the products of combustion in this boiler varies somewhat from that found in other boilers of the water-tube type. These boilers are usually set up in pairs near each other, and the combustion chamber of the two is a common space located between the two nests of tubes. Yet each boiler is fed separately and has a distinct circulation of water of its own. The bottom row of tubes is raised about 2 ft. above the surface of the grate. In order to prevent the gases of combustion from passing between the interstices of the bottom row of tubes, simply formed tiles are laid over and upon them, and a similar layer is placed on the top row. The spacing of the outer vertical row is also closed for about two-thirds the height from the top by sheet metal shields.

The design is very clearly shown in fig. 9, wherein the directions indicated by the arrows show the course that the gases of combustion must follow. They will be seen to pass beneath the bottom row of tubes into the common combustion chamber, thence sideways through the nest of tubes and then to spread out over the bottom of the drum.

This arrangement is the result of an attempt to obtain the most perfect combustion possible, by remembering that the direct rising of the distilled gases through the interstices of the nest of tubes would subject them to such a cooling temperature that the unburned gases could not unite with the oxygen.

The interior cleanliness of the tubes and water legs can be easily maintained through the numerous openings in the latter. A damaged tube can either be plugged or cut out and replaced.

III. The Oriolle boiler (figs. 10 and 11), as built by the Messrs. Oriolle at Nantes, resembles the Lagrafel boiler in that it consists of two water legs which are connected to each other by a number of straight tubes. Only one of these legs, however, is in communication with the steam drum, and that is through a pipe. The tubes are located directly over the fire, and only single tubes are ranged along the sides of the furnace, as is done with the Lagrafel boiler. The rows of tubes are staggered, so that a tube is placed over the spacing of the row beneath. The gases which rise from the fire through the spaces in this nest of tubes accomplish a greater heating effect by this arrangement than would be the case were the tubes placed in vertical rows. The course of the draft reminds one of that of the Lagrafel boiler in its older form.

While in service the water-level is kept below the top of the upper row of tubes. The water, therefore, flows out from the lower row of tubes into the front water leg and upward in it to the water-level and then back through the adjacent tubes to the leg at the rear.

The tubes that are used are 2 in. in diameter. The circula-

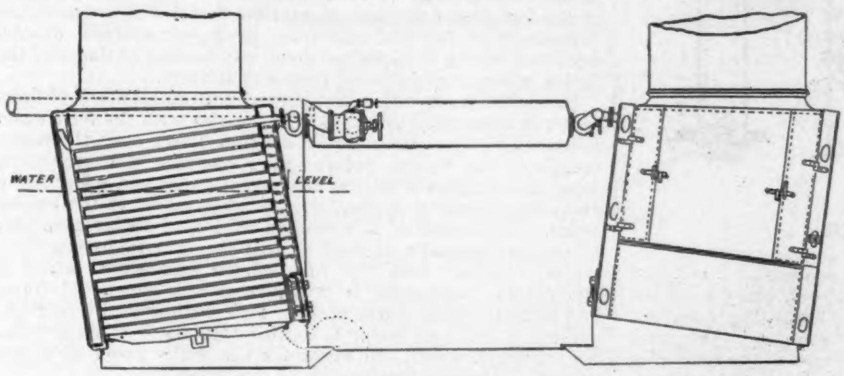


Fig. 10.

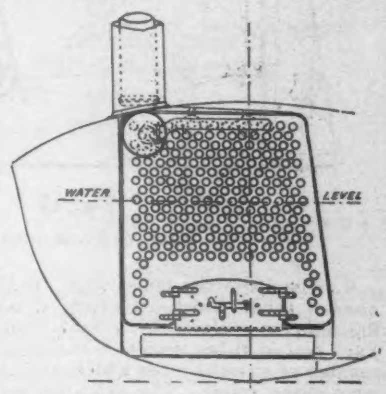


Fig. 11.

THE ORIOLLE BOILER.

tion should be brisk, and no deposits would be formed even though impure water were used in service. Nothing but steam is contained in the upper tubes while the boiler is at work, and this steam is here superheated. As these tubes have only a slight heating efficiency as compared with the tubes that are filled with water, it follows that they burn out sooner than the latter.

IV. The Yarrow water-tube boiler (fig. 12) also consists of two water legs, which are connected with each other by a nest of straight tubes and opening into a cylindrical boiler shell forming a steam drum. The water tubes extend even through outer sheets of the water legs, and are fastened in each of the four sheets by expanding, which is done with a simple machine. The tubes that are used are made of iron, are 1½ in. outside diameter, and are cut with slots at that point which lies within the water leg; their ends are closed with a simple screw plug. The water circulation in this boiler is exactly the same as that of the Lagrafel D'Allest boiler.

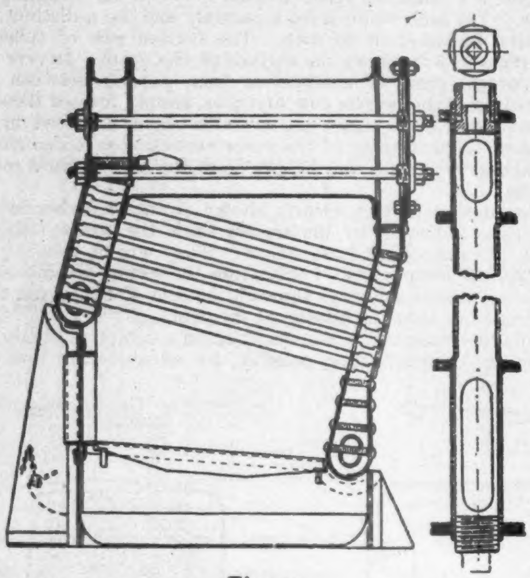


Fig. 12.

THE YARROW BOILER.

V. The Belleville boiler (figs. 13–16) consists of a series of nests of tubes, which are arranged near each other over the fire and are enclosed by a wall of heat-insulating material. Each nest of tubes, which is called an "element," contains a number of straight tubes which are arranged in the form of a compressed spiral. The tubes are screwed into forged connections. The connections between the elements are arranged vertically the one over the other, and so located that the upper end of one tube lies on the same level as the lower end of the next tube. The connecting pieces or heads at the front end have two openings through which the opening of the tube can be examined or the tube cleaned. With these facilities an internal inspection can be made with an electric lamp, which is fastened on the end of a stick for the purpose and run down into the tube. A simple hand-hole plate with a yoke and screw is used for closing this opening. All of the tubes are slightly inclined. For war vessels tubes of 3 in. diameter are ordinarily used, but for other vessels the diameter of the tubes is usually put at 5 in. The thickness of these tubes is usually ¼ in. for those in the upper rows and ⅛ in. for those in the lower.

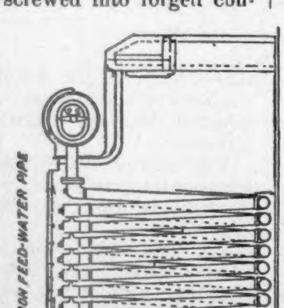


Fig. 13.

At the front end each element is brought into direct connection with the common feed-water pipe by means of the bottom head, and, at the top, it is connected in a similar way by the top head with the outer half of the boiler-shaped vessel forming the steam drum. Furthermore, the steam drum communicates through system of piping laid in its bottom and outer half of its shell with a horizontal water-pipe. It is in this system of piping that the water for the boiler is purified. The feed-water is delivered into the steam drum on the side opposite to that from which the circulation pipes are led off.

While in service the water-level is kept somewhat above the bottom of the drum, and the circulation of the water flows through each element successively—that is, out of the common horizontal water tube down to the bottom tube, into which latter the water flows and is heated, so that it passes through the back connection as a mixture of steam and water into the tube lying above it, where more steam is generated, and this continues from one to the other. Through each tube of an element there, therefore, streams not only the steam that has been generated in the tubes that lie below it, but also that which it has itself produced. Out of each element there pours a mixture of steam and water, which is finally separated in the drum by a perforated plate construction. There on the common bottom the hot water mingles with the incoming feed-water, and flows out through the circulation tube into the feed-water purifier and from this into the common horizontal water-pipe, whence it again passes into the circulation through the elements.

The fact that the steam generated in the lower tube is compelled to pass through those at the top, increases the rapidity of the circulation of the water over that which we have found in other water-tube boilers where the steam flows directly from each tube into the drum. On the other hand, the speed of the circulation suffers a marked diminution through the manifold changes of direction due to the course which it has to follow in passing from one tube to the next.

The feed-water purifier is a peculiarity of this form of boiler; the addition itself is dependent upon the method of handling the feed-water, and has been developed as the result of practice.

It is a well-known fact that, in spite of the greatest economy in the consumption of lubricants, and in spite of the passing of the feed-water through separators, that it will take a certain percentage of fats and salts from the upper surfaces of condensation which is deposited upon the heating surfaces of the boiler, where it gives many causes of anxiety.

In service these boilers are served with small doses of lime-water in attenuated solutions. It mingles with the feed-water delivered by the pump into the drum, flows over the whole length of the bottom before going out into the circulating tube, and mingles with that mixture of steam and water rising from the elements, so that it is quickly raised to the boiling point. As a result of this sudden raising of its temperature, all of the lime-salts as well as that brought in by the feed-water, together with the lime of the lime-water, which is straightway separated, is precipitated in a powdered form, and mixing in this finely divided state with the oily particles present in the feed water is carried into the feed-water purifier, through which the water for the boiler flows at a low velocity, allowing the slime to be deposited.

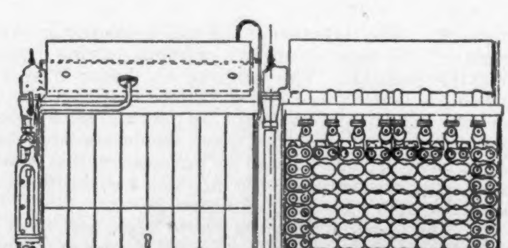


Fig. 14.

THE BELLEVILLE BOILER.

Investigations have shown that this process is very perfectly carried out, and that the heating surfaces remain clean; even though sea-water is used as a source of supply for wasteage, the heating surfaces show no signs of deposits, while in the purifier a thick slimy deposit will be found.

This method of handling the feed-water with lime has also been used in the working of the Lagrafel D'Allest boilers, wherein 4 lbs. of lime was used each 24 hours per 1,000 I.H.P.; yet with this boiler the separation from the feed-water before coming in contact with the heating surfaces was not successful, and the deposits were found chiefly at the lower portion of the back water leg, where the water is most quiescent.

All the connections of the Belleville boilers are made with screws. The tubes are screwed into the back heads and the connection strengthened by check nuts lower down. The front heads have a slip joint, with threads in which the end of the tube is screwed, and where it is held by a check nut. It is only at the tube ends that the flame impinges against a double thickness of metal.

The simple manner in which the repairs of this boiler are provided for deserves to be followed out, for a boiler can be cleared of any desired element by slacking off the fastenings of the upper and lower surfaces, when it can be drawn out into the fire-room. Any desired tube in this element can then be removed, by taking off the unscrewed ring piece which connects it with the front head and slipping the tube out of the back head, from which it has been unscrewed. A new tube with a new ring piece can then be put in and the element put back, so that the boiler can be filled and under steam again in about six hours, so that all the work of a machinist with the help of the fireman can be dispensed with.

(TO BE CONTINUED.)

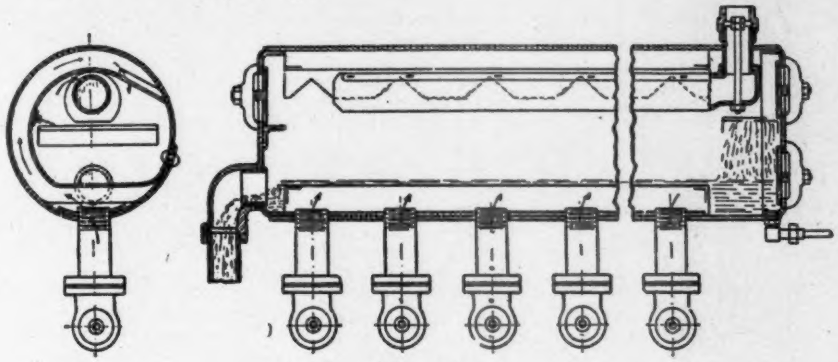


Fig. 15.

STEAM CHAMBER OF THE BELLEVILLE BOILER.

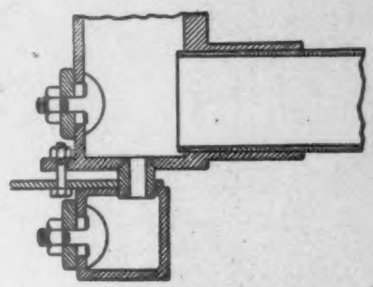


Fig. 16.

COMMON FEED-WATER PIPE.

FREE LABOR AND TRADE UNIONISM.

In the annual report of the executive of the National Free Labor Association, presented at the annual conference held in October, some statistics are given concerning the present position of free labor in Great Britain. It is stated that up to the end of August last no fewer than 228,000 seamen had been registered as free labor men, and a large number of these were known to have previously belonged to "Wilson's Union." In the metropolitan docks the demand for free labor tickets has been so great that it has been necessary to limit their issue according to the actual number of men for whom employment could be found. "The aggressive attitude of Messrs. Burns, Mann, Tillett and Wilson, with their 'new unionism,' has," the report proceeds, "resulted in their utter defeat, and has converted Southampton, Plymouth, Cardiff and Dublin, as well as Hull, into free labor ports." Discussing the present strength of the trade unionists, the report says that out of 9,786,073 male persons of 20 years of age or over who are working for their living in the United Kingdom, only 1,109,014 are members of trade unions, leaving 8,677,059 to be described as free labor men, non-unionists, "blacklegs," "scabs," "knobsticks," or anything else but trade unionists. Since the great dock strike "persistent and cruelly unjust efforts" have been made to force unwilling men to join the trade societies, many of which are run on purely party grounds or to further the socialistic schemes of the union leaders. "But what success," the report continues, "has attended the efforts of Mr. John Burns? The voluntary and compulsory additions to trade unions between the 1891 and the 1892 returns left a total of 18,000 less than the desertions. The numerical strength of the unions has gone back in spite of his great efforts, and confidence in the management of the agitators and self-seekers has been shaken among those who remain true—voluntarily, or under dread of the consequences. We believe in the need of combination, but not in the 11 per cent. being allowed to coerce 89 per cent. of the workmen of the country." The report also deals with the question as to what effect trade unionism has on the trade of the country, and on this point it says: "The value of fixed capital laid idle by the strikes in various trades during 1891 amounted to £9,493,000. But the most fearful indications of the evil wrought by strikes which occurred in 1891, 1892 and 1893 are shown by the exports from Great Britain during the three quarters of each of those years ending September 30. The totals were: In 1891, £187,475,-396; in 1892, £170,480,788; in 1893, £165,393,621, or a difference of nearly £22,000,000 between 1891 and 1893." Notwithstanding this diminution in production the bill of the nation for food and drink imported has, the report adds, not stood still or diminished, but, on the contrary, has increased, and Great Britain has been paying this bill, not out of income from material produced, but out of capital.

MANIFESTO OF THE NATIONAL FREE LABOR ASSOCIATION.

Evidently there is rebellion against the trade unions in Great Britain, as is shown by the following manifesto, dealing with the recent Trade Union Congress, has been prepared by the National Free Labor Association, and which the *Times* said a short time ago will be issued in the course of a few days:

"After the series of ridiculous farces enacted at the late Trade Union Congress at Norwich, we invite your attention to the policy now entered upon by the leaders of the 'new' trade unionism, and ask you to compare their wild theories with the sturdy common sense of the well-tried and veteran labor leaders who have served you so well in the past.

"At the recent congress at Norwich the following resolution was actually passed:

"'That, in the opinion of this congress, it should be made a penal offense for an employer to bring to any locality extra labor when the existing supply was sufficient for the needs of the district.'

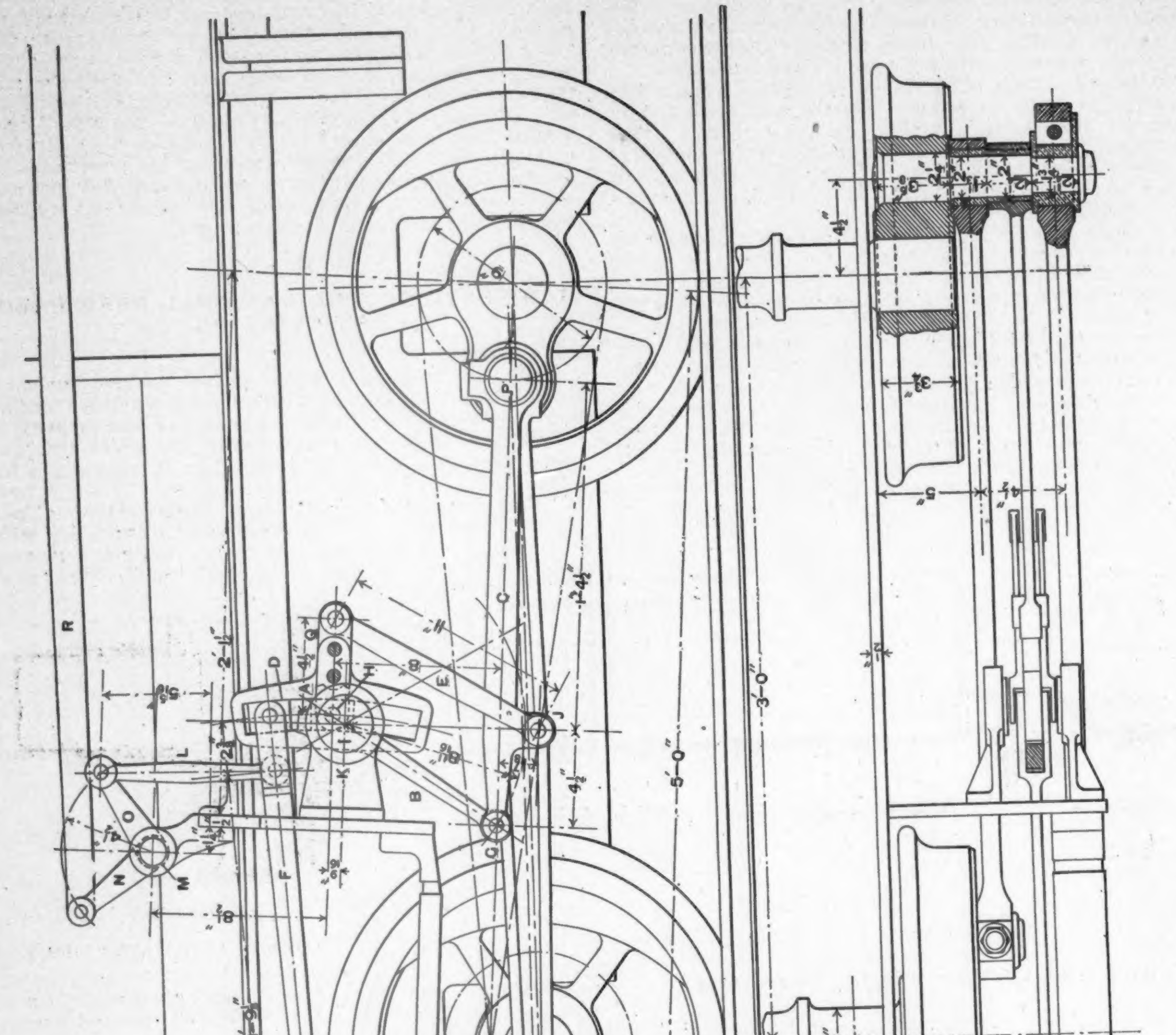
"Now, we ask you to consider the full meaning of this insolent demand. (*a*) It means that no employer will be able to give you work unless you belong to a trade union. (*b*) It means that no British workman shall be free to work except he receives the precious permission of the trade union officials. (*c*) It means that an insidious attempt is being made to coerce you into joining the trade unions.

"But that is not all. The congress, which professed to have for its object the freedom of labor, has a curious idea of that policy, for it resolves to urge upon the Government the advisability of reintroducing the Employers' Liability Bill, with the clause which forbids workmen to make better terms with their employers than the law courts would enable them to do.

"Fellow-workmen, we do not think you will call this freedom; we think you will call it tyranny, and that, too, in one of its worst forms.

"Has now every workman the right to make terms with his employer as to insurance against accidents? We think you will say, 'Yes, undoubtedly;' but the trade union officials say, 'No; let us destroy these mutual insurance societies in order that we may wield more power over the destinies of their members;' and we therefore maintain that a congress of trade union officials which advocates the passing of a measure forbidding 'contracting out,' has no right to profess to champion the rights of labor, but that it has grossly misrepresented the opinions of the vast majority of the working classes.

"Evidently wishing to cap these demands with something more ridiculous still, the congress passed a resolution affirming



BAGUELEY'S VALVE MOTION.

the desirability of nationalizing, not only the land, mines, and railways, but all the means of production, as if there were the slightest chance of this wild dream ever being realized; if newspapers had been included in the list of things the congress wished to nationalize, would not there have been a tremendous outcry raised by those journals which are at the present moment engaged in supporting these trade union officials, and yet there is far more sense in the theory of nationalizing the press than in that of nationalizing the land and its minerals."

BAGUELEY'S VALVE-GEAR.

THE full-page engraving herewith represents a very ingenious and simple valve-gear, which is the invention of Mr. Ernest E. Bagueley, of Stafford, England. To readers who are familiar with the principles of the link-motion and "radial" gears, the operation of the mechanism shown by the engraving will be obvious with little or no explanation.

The link *A* is suspended or supported by bearings *H*, which are journalled in an eccentric *I* attached to the pendulous lever *B*. This eccentric oscillates in the bearings *K*, and the lower end *G* of the link *B* is driven by the rod *C*, which is attached to the crank-pin *P*, or may be pivoted to the connecting-rod. The motion thus imparted to the lower end of *B* and to the eccentric *I* moves the link *A* in a horizontal direction opposite to that of the piston, an amount equal to the lead. The link *A* has a horizontal arm *Q* attached to its back side. The end of this is connected by another link *E* to the rod *C*, the vertical movement of which is transmitted to the end of the arm *Q*, which thus oscillates the link. This oscillation added to the lead gives the valve its required travel. The link is connected to the valve-stem by a block *D* and radius link *F*, which is raised and lowered by a tumbling or reverse shaft *M* in the usual manner.

The inventor says that "the link *A* is held in position by the rod *E*, the length of which is such as to have the error due to its end traveling in an arc corrected by the same movement of the end of the lever *B*, which gives the lap and lead movement. . . . The motion gives equal leads, port openings, and cut-off."

It is a very simple form of gear, and may be readily applied to the ordinary type of "American" locomotives, and it seems to have very decided merits.

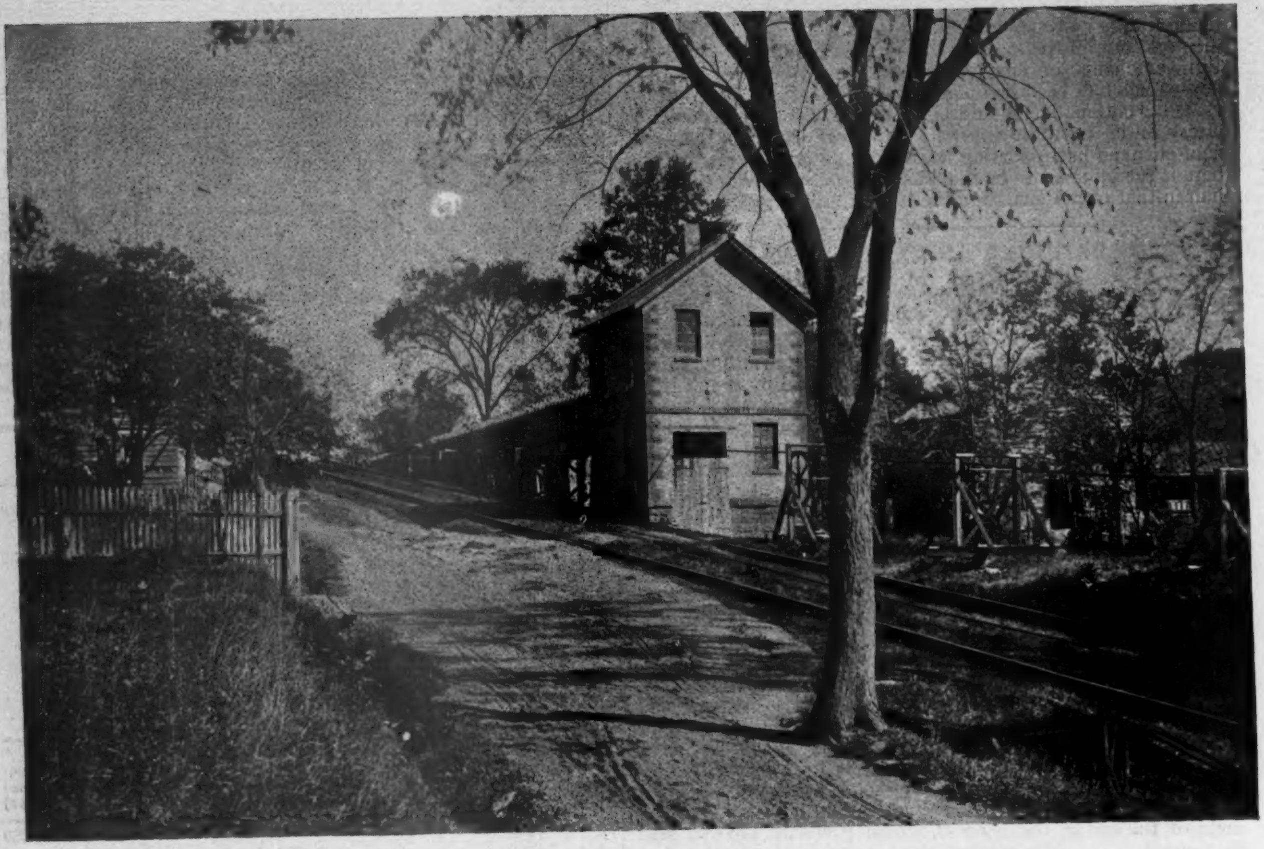
THE BOW FIRE OF MODERN SHIPS.

THE following interesting letter from a correspondent of the London *Times* has recently been published in that paper:

"As a broadly stated proposition, it is true of the modern British man-of-war that upon an object lying directly ahead of her she can bring to bear a smaller number of guns than can be brought to bear upon a similarly situated object by the modern foreign warship of corresponding class and less displacement. It is also true, as a general rule, that the British guns thus capable of firing right ahead are, although fewer, somewhat heavier, especially in battleships, than the foreign ones. Apparently it has been assumed by us that, so far as bow fire is concerned, superiority of caliber will compensate, at least to some extent, for numerical inferiority of pieces; and since, even in our latest designs, the principle has been persisted in, in spite of the fact that all foreign countries have adopted the diametrically opposite system, it is important, before we lay down any more ships, to inquire whether or not we are herein following a sound and defensible policy. For the proper consideration of the problem it is necessary to bear in mind certain axioms. One of these is that it is desirable, both because of the relative smallness of the target thereby exposed, and also because of the manœuvring advantages that are thereby retained, to fight as much as possible bows on. Another is that smaller guns can be fired with proportionately greater rapidity than larger ones. Another is that multiplication of pieces reduces the risk of the total disablement of the gun armament of a ship. And yet another is that, although a successful shot from a larger gun may be proportionately more destructive than a successful shot from a smaller one, it is easier to make accurate shooting with smaller guns than with larger ones; and that, not only on account of their greater facility of manipulation, but also on account of their greater rapidity of fire, smaller guns may be expected to make more hits than larger ones. From this it may easily result that in a given length of time a comparatively small gun may do more aggregate damage than a very large one, seeing that the small one is capable of getting rid of the greater number of projectiles, and possibly even of the greater weight of metal, as well as of making the larger proportion of hits. It is further necessary, in order to be able to weigh the question, to assess, at least roughly, the relative quickness of fire of the various classes of guns. It is probably fair to assume that, supposing each weapon to be ready loaded at the beginning of an action, guns can fire as follows, due attention being paid to aim, in a space of 3 minutes: Breechloaders of 10 in. and upward, two shots; of 8 in. and less than 10 in., three shots; of 6 in. and less than 8 in., four shots. Quick-firing guns of 6 in., 10 shots; of 4.7 in. and less than 6 in., 12 shots; of 3.9 in. and less than 4.7 in., 14 shots. In the comparisons which are to be made, guns of less than 3.9 in. (10 centimeters) caliber are not considered, as they do not pierce any formidable thickness of armor. The period of 3 minutes has been chosen as the unit for the purposes of comparison, since in 3 minutes two vessels approaching one another at a speed of 15 knots would reduce the distance between them from 2 miles to ½ mile. In other words, in that brief space of time they would traverse the whole zone in which, while the gun is most dangerous, the torpedo is absolutely harmless.

"Here, then, is a statement of what can be done by the bow guns of some typical modern ships in 3 minutes:

	Ships.	Number and Nature of Guns bearing right ahead.	Bow Fire in Three Minutes. Number of Rounds.	Total Weight of Metal Thrown.	Total Muzzle Energy Developed.
				Lbs.	Ft.-tons.
Battleships.	*Royal Sovereign*, 14,260 tons (British)	Two 13.5-in. B.L.	4	5,000	140,920
		Two 6.0-in. Q.F.	20	2,000	68,340
		4 guns	24	7,000	209,260
	Charlemagne, 11,232 tons (French)	Two 11.8-in. B.L.	4	2,504	119,640
		Six 5.5-in. Q.F.	72	5,040	212,544
		Four 3.9-in. Q.F.	56	1,568	65,632
		12 guns	132	9,112	397,816
	Sardegna, 13,360 tons (Italian)	Two 13.5-in. B.L.	4	5,000	140,920
		Two 6.0-in. Q.F.	20	2,000	68,340
		Two 4.7-in. Q.F.	24	1,080	37,248
		6 guns	48	8,080	246,508
	Oregon, 10,231 tons (United States)	Two 13-in. B.L.	4	4,400	134,508
		Four 8-in. B.L.	12	3,000	89,976
		Two 6-in. Q.F.	20	2,000	64,080
		8 guns	36	9,400	288,564
	Renown, 12,350 tons (British)	Two 10-in. B.L.	4	2,000	57,720
		Two 6-in. Q.F.	20	2,000	68,340
		4 guns	24	4,000	126,060
	Jauréguiberry, 11,824 tons (French)	One 11.8-in. B.L.	2	1,252	59,820
		Two 10.8 in. B.L.	4	1,904	51,200
		Four 5.5-in. Q.F.	48	3,360	141,696
		7 guns	54	6,516	252,716
	Sinope, 10,180 tons (Russian)	Four 12-in. B.L.	8	5,848	153,120
		Four 6-in. B.L.	16	1,168	33,280
		8 guns	24	7,016	186,400
1st Class Cruisers.	*Impérieuse*, 8,400 tons (British)	Three 9.2-in. B.L.	9	3,420	77,598
		Two 6.0-in. B.L.	8	800	19,392
		5 guns	17	4,220	96,990
	New York, 8,500 tons (United States)	Four 3.0-in. B.L.	12	3,000	89,976
		Six 4.0-in. Q.F.	84	2,772	84,000
		10 guns	96	5,772	173,976
	Dupuy de Lôme, 6,297 tons (French)	Two 7.6-in. B.L.	8	1,320	63,152
		Three 6.3-in. Q.F.	30	3,300	138,960
		5 guns	38	4,620	202,112
	Capt. Prat, 6,900 tons (Chilian)	Three 9.4-in. B.L.	9	2,853	84,690
		Four 4.7 in. Q.F.	48	2,208	93,312
		7 guns	57	5,061	178,002
2d Class Cruisers.	*Astræa*, 4,360 tons (British)	One 6-in. Q.F.	10	1,000	34,170
		1 gun	10	1,000	34,170
	Chasseloup-Laubat, 3,722 tons (French)	Three 6.3-in. Q.F.	30	3,300	138,960
		Two 3.9-in. Q.F.	24	672	28,128
		5 guns	54	3,972	167,088



VIEW LOOKING UP THE INCLINED PLANE AT BLOOMFIELD, N. J.

VIEW LOOKING DOWN THE INCLINED PLANE AT BLOOMFIELD, N. J.

"Special notice is directed to the astonishing strength of the *Charlemagne*, *New York*, *Jauréguiberry*, *Capitano Prat* and *Oregon*.

"It will be seen that in every case the bow fire of the British ships, tested by this 3-minute standard, is weaker, not only in number of rounds, but also in weight of metal thrown and in total muzzle energy developed, than the bow fire of foreign ships of similar class and of about the same or of smaller displacement. The attention which, especially in France and the United States, has been devoted to the increase of end-on fire has hitherto passed almost unregarded here; but our disparity in this respect has now become so marked that we can no longer afford to disregard the subject."

THE INCLINED PLANES OF THE MORRIS CANAL.

In our issue for January, 1893, we illustrated and published a short description of the inclined planes that are in use on the Biwa Canal, in Japan, which were built under the superintendence of Mr. Sakuro Tanabe, of the Imperial University of Japan. At the time of the publication of the article we were not aware that Mr. Tanabe had visited this country as a member of a Japanese commission, to investigate the inclined planes in use on the canals of America, with the view of adapting them to Japanese services; but the fact is that this commission made a very careful study of the inclined planes in use on the Morris Canal, and it was from the drawings and memoranda obtained during this visit that the details of the planes on the Biwa Canal were prepared. Thus did we go abroad to learn the news of home.

It was at the close of the first quarter of this century, before the advent of railroads and when canal transportation still held the pre-eminent position as an economical method of transportation, that the charter was granted for the construction of the Morris Canal, that was to and did afford a cheap means of transportation for merchandise between the Hudson and the Delaware, and especially as an eastern outlet for the coal of Pennsylvania. To be exact, the charter for the construction of this canal was granted on December 31, 1824, and in the following July ground was broken and the work pushed to completion, which was accomplished six years later, in August, 1831—that is, the canal was finished through to Newark, but it was not until 1836 that it was carried through to Jersey City.

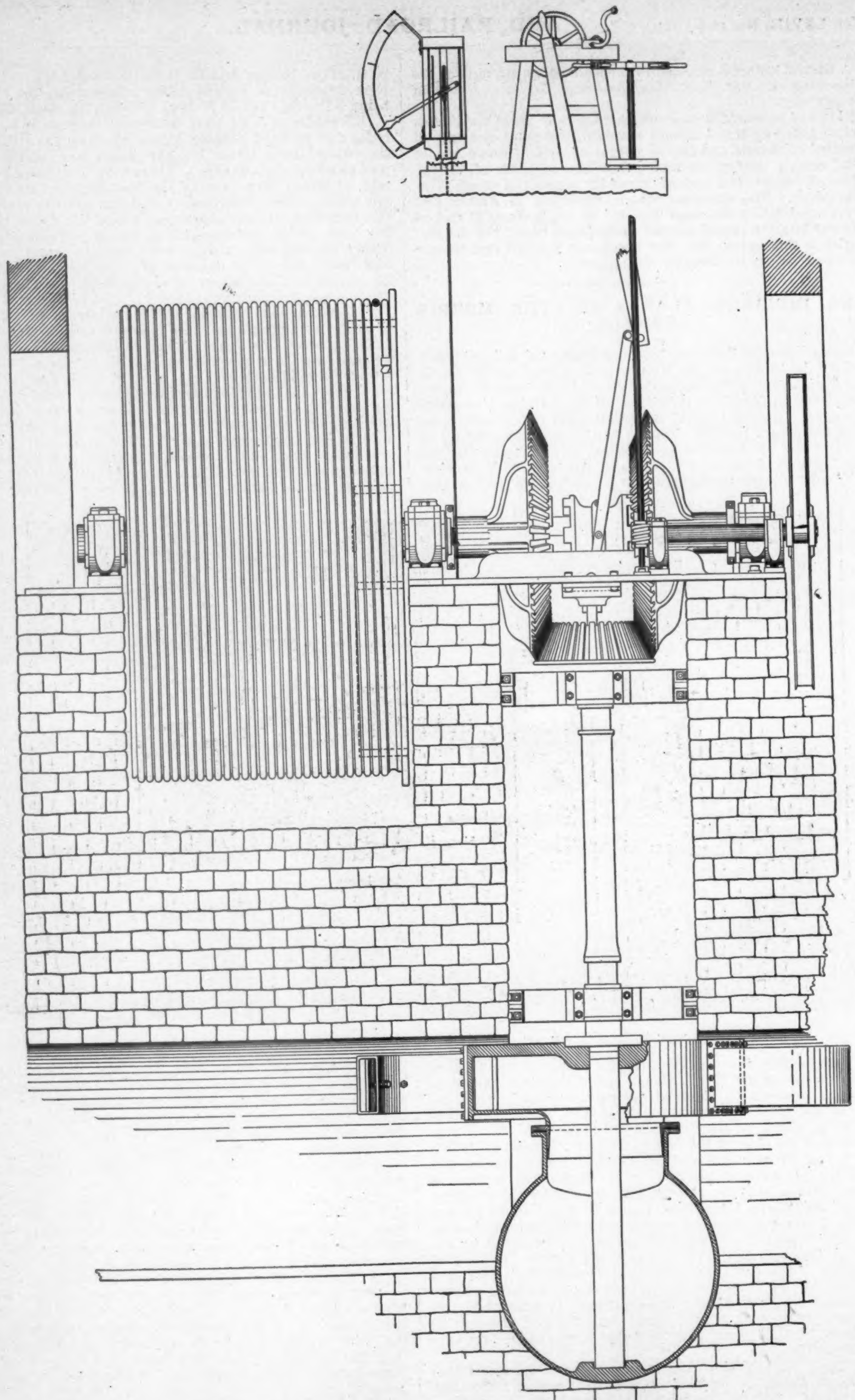
In these days of ship canals connecting widely separated bodies of water, the original Morris Canal was of Lilliputian dimensions. As first constructed the depth of the water was only 4 ft., in which boats of 18 gross tons capacity and drawing 3 ft. of water were floated. The breadth of the canal was 20 ft. at the bottom and 32 ft. on the water-line. The locks were naturally of corresponding dimensions, the chambers being 9 ft. wide and 75 ft. long between the miter sills.

Differences in level were overcome, then as now, by both locks and inclined planes, depending upon the lift between the two adjacent levels, but the planes were of the lock as well as of the summit type. There were 23 of these planes all told, of which three were of the lock type and 20 were summit planes. The difference is that the summit plane is one like that shown in our engraving, where the incline rises over the brow of the embankment at the end of the canal, and thence passing over it dips down into the water, while the lock planes end in the chamber of a shallow lock, into which the boat is run, and where, after the gates have been closed, water is admitted raising the level to that of the canal above.

This system was continued until the winter of 1835–36, when all of the summit planes were changed to lock planes. The probable reason for this was that an increase in the length of the boats was in contemplation, and there was a difficulty in carrying a solid boat over the brow of the incline on a single car. The canal remained in this condition until 1841, when the demand for better facilities and larger boats led to the widening of the planes by 2 ft., while the locks were widened to 11 ft. and lengthened to 95 ft. The traffic still continuing to increase, work on the general enlargement of the waterway was begun in 1845, when the breadth of the canal was increased to 25 ft. at the bottom, to 40 ft. at the water-line, and the depth of water made 5 ft. instead of 4 ft. At the same time the section boats, like those shown in our engravings, were first introduced, and these had a cargo capacity of 44 gross tons. These boats are really two separate vessels, but dependent upon each other in that one has the bow and the other the stern with the rudder. They are hinged together at the deck-line by heavy iron bars in a manner exactly similar to that shown on the half section of the car in our engraving. As these boats were of such a construction as to be easily carried over the brow of a summit plane, and as this style of plane is less expensive and troublesome to operate than the lock type, all of the planes west of the summit were rebuilt and converted to summit planes using wire ropes in the winter of 1850–51. The work was, however, begun in the winter of 1847–48, when plane No. 6, west, was so reconstructed. This work was followed at once by the remodelling of all of the planes east of the summit to similar arrangements, but the work proceeded more slowly, and it was not until 1860 that the last change had been made, although it had been commenced in 1852 and continued without interruption until completion.

This enlargement and change in the capacity of the canal was followed at once by the introduction of larger boats in 1860, when 70 gross tons was the limiting capacity. This

THE CREST OF THE INCLINE AT BLOOMFIELD, N. J., SHOWING BOAT LEAVING THE WATER.



SECTION OF POWER HOUSE OF INCLINED PLANES ON THE MORRIS CANAL.

rating has been only slightly increased since then, and the average cargo is now from 75 tons to 80 tons, with the boat drawing 4 ft. of water.

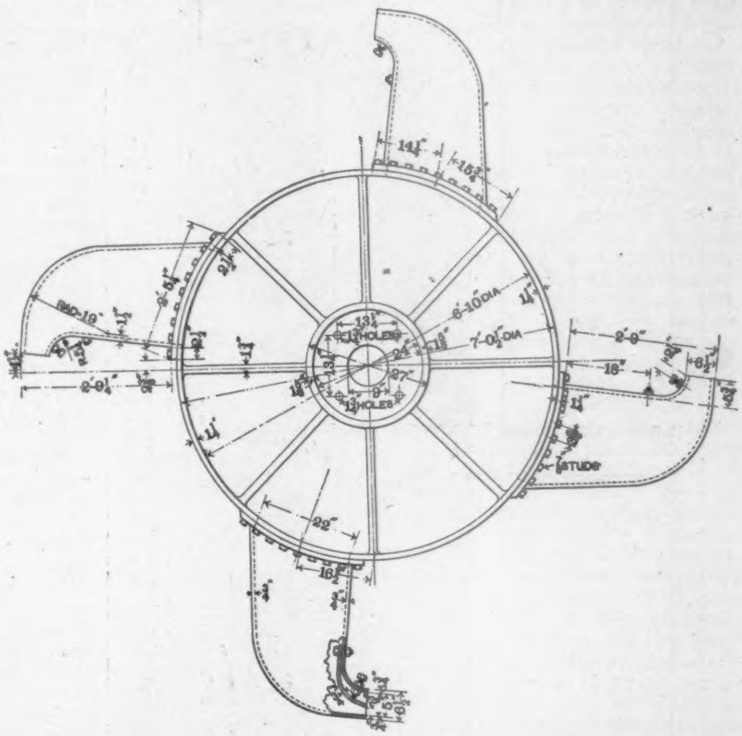
As we have already said, the canal starts from tide-water level at Newark and runs to Phillipsburg on the Delaware River. In traversing it a boat passes through 16 lift locks and over 12 inclined planes to the summit, which is at Lake Hopatcong. The elevation above the sea-level at this point is 914 ft., of which 156 ft. were gained in the locks and 758 ft. on the inclined planes. From the summit the drop to the Delaware River at low water is made by means of 11 inclined planes and seven locks, giving a total fall of 760 ft., of which 69 ft. is accomplished by the locks and 691 by the planes. This survey indicates that the Delaware at Phillipsburg is 154 ft. above tide-water. Water is supplied by the Ramapo, Pequonock, and Wyanock rivers, from Greenwood Lake, which is artificially raised 15 ft. by the canal dam, and from Lake Hopatcong, which is raised 11 ft. above its normal level by similar means. Then there are other reservoirs known as the Cranberry Reservoir, Bear Pond, and the Rockaway River.

At present the tonnage passing through the canal is from 1,500 tons to 1,600 tons a day, and the time required for the passage from end to end, a distance of about 75 miles, is in the neighborhood of four days, all boats lying to at night.

The engravings published on pages 554 and 555 are taken from photographs of the plane at Bloomfield, N. J. That on page 555, which is taken looking east from the end of the canal, shows the brow at the summit of the plane with the car and boat which have just come out of the water passing over the crest, one-half being on each incline. The whole length of the incline is shown by the two engravings on page 554, the photographs having been taken from the same point, one looking up and the other down. In one a boat is seen ascending the plane, and in the other the power-house, with the flume leading to it from the upper level, together with the ropes, are clearly shown. This plane is about 560 ft. long, with a lift of 56 ft., or 1 in 10, which is the average inclination of all the planes on the system. The machinery used for hauling the car is of the simplest description, and is interesting for that very reason. Water is used as the prime mover throughout on every plane, and the wheels are geared directly to the drum. In this the machinery at the inclines of the Biwa Canal, in Japan, differs from its American model, in that an electric motor is interposed between the wheel and the winding drum. The wheel, an engraving of which is given in plan on page 557, and in the section of the power-house on page 556, is of the simplest type of reaction wheels. Originally the wings were cast solid with the main body of the wheel, but as a slight breakage would cripple and destroy the whole wheel, the design shown in our engravings was adopted and is still used. The whole is of cast iron, and the nozzles are arranged with adjusting plates to fix the outflow and power in accordance with the head of water that is available. It is unnecessary to recapitulate the dimensions of the wheel as they are given on the plan, except the heights. The opening is 1¼ in. horizontally and 16 in. vertically. The total height of the wheel over flanges is 22½ in. Water enters from below, and while work is being done it takes the weight off from the step that carries it through an auxiliary shaft resting on a step in the trunk, and in contact with a brass block 2 in. thick beneath the main shaft. The wheels are undoubtedly very wasteful of water in comparison with the amount of power that they develop, which, by the way, has never been measured; but as a certain amount of water is required to supply waste and the locks on the lower levels, it is as well to let it run through the wheel as idly through a flume, so that under the circumstances there is no occasion to economize.

The engraving on page 557 gives a clear idea of the arrangement of the machinery in the Bloomfield plane house. The drawing was made especially for this engraving from measurements taken on the spot, and is accurate except that the distance from the top of the water-wheel to the horizontal bevel gear should be about 8 ft. more than is here represented, which is put at 10 ft. 11 in., the shortening having been done to meet the exigencies of the space allowable for the engraving. This distance, however, varies with each plane. The shaft rising from the wheel is 9¼ in. in diameter, and is keyed at the upper end to a bevel gear of 3 ft. outside diameter meshing in with two others, each 3 ft. 10 in. in diameter, the common pitch of the teeth being 2¼ in. These two vertical gears run loosely on the main horizontal shaft, being held in position by the bearing and collars, and furnished with an open clutch on the faces of the hubs opposite each other. Between the two a heavy clutch-head slides over a feather in the shaft, engaging one or the other of the vertical gears according as it is desired to turn the drum in one direction or the other. The clutch jaws are four in number, each 2¾ in. deep, and with a face so that ¼ in. clearance is given between the back edge and that on the clutch of the gear. This clutch is shifted to and fro by the combination of levers shown in the engraving, the upper end of which projects above the platform in the upper story of the plane-house.

The shaft upon which these level gears run is of wrought iron 8 in. in diameter, and turns in boxes 12¼ in. long. On one end close to the wall of the building it carries a brake-wheel 8 ft. in diameter, with a face of 5 in. between flanges,



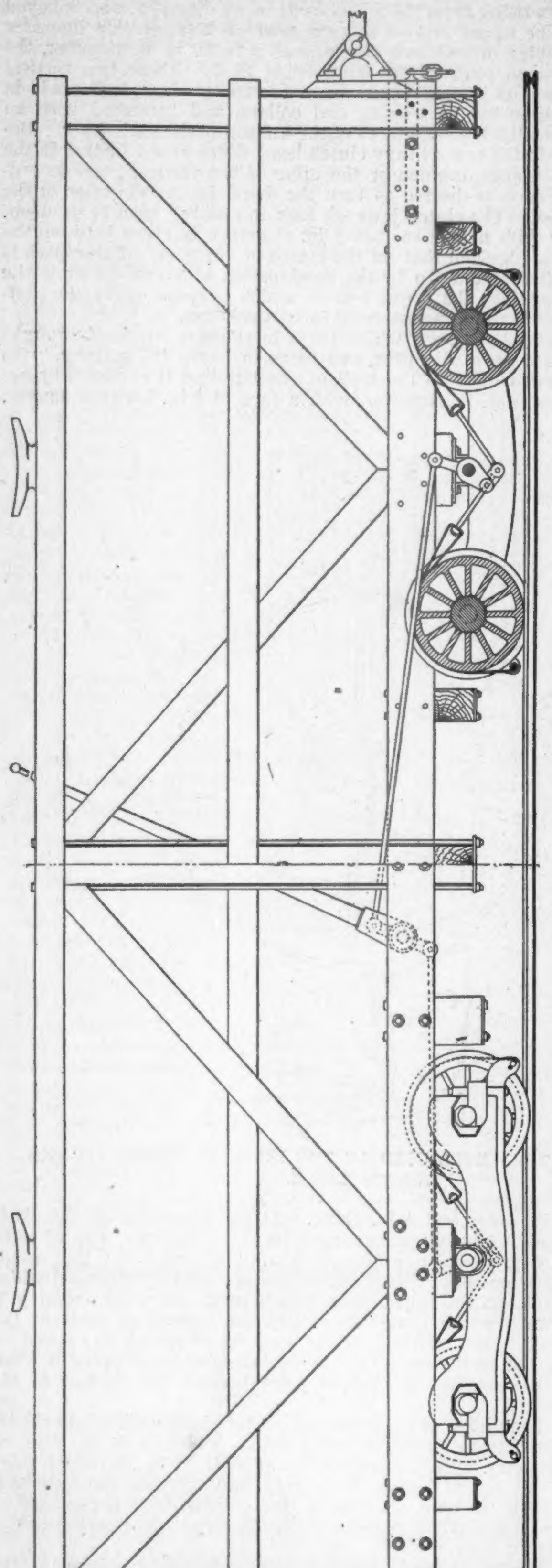
PLAN OF WATER-WHEEL USED AT THE INCLINED PLANES ON THE MORRIS CANAL.

1 in. deep and ½ in. thick. At the other end of the shaft there is a heavy pinion about 30 in. in diameter, with 23 teeth of 4 in. pitch and a face of 15 in. The brake-band that clasps the wheel is of ¾-in. iron, and is operated by the hand-wheel shown on the upper floor, which turns the worm meshing in with a worm gear that rotates the tightening shaft of the brake-band. This brake is used for checking the speed of the car on its way down the incline, and for stopping it when it has reached the proper point beneath the surface of the water.

The pinion at the other end of the shaft meshes into the internal teeth on the winding drum, which is 11 ft. 8 in. in diameter, with a working face of 6 ft. 11 in., in which there are 31 grooves, each 1½ in. deep, and carrying the rope that is 2¼ in. in diameter and of steel. This drum is mounted on a cast-iron shaft 11 in. in diameter, swung in heavy bearings 12½ in. long.

For use in foggy weather there is a light level gear on the main shaft meshing in with a pinion on a small vertical shaft that operates an indicator, showing the location of the car at all times. The marks on the face of this indicator show the car in position beneath the water on the upper level, on the brow at the summit, and below water on the lower level. This, with the winding apparatus for raising and lowering the gate in the operating room, is all of the machinery in use. From the windows of the room a clear view up and down for the whole length of the plane is obtained.

The track upon which the car runs has a gauge of 12 ft. 5 in.,



SIDE ELEVATION OF ONE-HALF OF CAR USED FOR TRANSPORTING BOATS ON THE INCLINED PLANES OF THE MORRIS CANAL.

and is composed of two T-rails 3 in. high, with a head of the same width and a flange of 4 in., the web being 1 in. thick. These rails are laid on stringers of 8 in. × 9 in. timber set on stone foundations. The hauling rope runs up and down in the center of the track, and is supported by carrying pulleys in the ordinary way. Where it runs under water it passes over horizontal submerged pulleys for the necessary change in direction.

The rope, after leaving the drum, runs out of the house in both directions over the carrying pulleys, beneath the surface of the water, and to the car, where one end is rigidly and securely fastened to one of the cross timbers, while the other is attached to a drum that can be turned to take up any stretch that may occur.

The car, like the boats, is made in two sections, each 32 ft. long over the main longitudinal sills. Each section is carried by four two-wheeled trucks, giving eight wheels to each. The wheels have flanges on both sides of the rail, and are 2 ft. 5 in. in diameter. The truck framing is of cast iron. The main longitudinal sills are 12 in. deep, and on them a side framing of the form shown in the car engraving is built. This framing is 9 ft. 6 in. high, and is strongly braced to withstand side shocks; the detailed arrangement being clearly shown in the accompanying engraving, which shows, however, only one section, the other being coupled to it by the heavy bars at the right-hand end. The wheels of the car are also controlled by brake-straps passing over them and operated by the long lever. But in actual practice no use is made of them, as the speed is perfectly regulated at the plane-house.

Two men serve to operate the plane: one in the house and the other on the car. When a boat appears the car is run down into the receiving basin, and the boat floated over it between the frames. When in position lines are made fast to the cleats on the top of the side frames, a signal given by hand or by a horn at night and in foggy weather, to the man in the house who starts the machinery. The car tows the boat out, and rising up the incline, catches it and carries it to the other level, an operation requiring about five minutes of time. Some of the planes are double tracked, so that a boat can be transferred in both directions at once, but for the most part they have only a single track, like this one at Bloomfield, which may be considered as a typical example of what is done.

DISTRIBUTION OF ELECTRICAL ENERGY IN THE MILLS OF MESSRS. J. FORREST & CO., AT SAINT-ETIENNE.

We have from time to time called the attention of our readers to the rapid progress which has been made in the development of electrical power for driving factories and shops, where a motor is used for each individual machine, and shafting, with its accompaniment of pulleys and belting, is entirely dispensed with. The examples which have been mentioned in our columns have been the new shop of the Northern Railway of France and the Columbia Mills of South Carolina. Through the courtesy of *L'Électricien* we are enabled to present illustrations and a description of the method of distribution of electrical energy in the ribbon manufactory of Messrs. J. Forrest & Co., at Saint-Étienne, in France.

Applications of electricity are rapidly propagated in the industrial region of Saint-Étienne, which presents, as is well known, very varied aspects. In fact, side by side with the large establishments devoted to metallurgical operations and to the workings of iron and steel, are mills of an entirely different kind, where silks and fine ribbons are manufactured. Messrs. Forrest & Co. own one of these factories, which is remarkable for the general arrangement and for the application which has been made of electricity therein. Our inclination would be to enter into the description of this with great fulness, urged on by the interest in the subject, but unfortunately our limited space will not permit.

The factory employs 500 people. The principal building faces the Rue Buisson, and has an underground floor on the level with the textile shops and the Rue St. Michael, a ground floor and three stories above. It is connected by two wings to a central building raised one story. The shop has a length of 154 ft., and the breadth 115 ft. Its roof is of the serrated type. It contains 100 looms for special articles, quadruple and sextuple plushes and ribbons, all of which are driven by electric motors. Next to the weaving-room, and separated simply by a glass partition, there is the spinning-room, also driven by electricity. The west wing is devoted to taffetas and lusters; this wing serves also for a storehouse for silks and for sorting and dyeing.

There is also a finely appointed printing-office, where stamps and rolls intended for the ribbons are prepared. In the central building there is a mechanical warping mill, with horizontal warpers for plushes and heavy stuffs, covering a superficial area of 3,530 sq. ft. The four floors of the main building are successively occupied, starting from the first with the weaving of ribbons, velvets, manufacture of boxes, and the warping of ribbons; the winding of raw silk is also driven by

electricity. Then there is the storehouse for the cards of the Jacquard looms and the duplicate parts for the looms. When the building was completed, in 1891, the question of the mechanical installation of the machinery was given the most careful attention by the proprietors. Different projects were discussed. For some years the progressive development of the industrial applications of the electrical processes had been rapidly advancing; the perplexity was therefore less than it would have been earlier, and the advantage of the method of transmitting power to individual motors was a matter to cause considerable hesitation. The system which had been adopted up to that time consisted of running the line shaft along the looms, from which a greater or less number of transmissions are taken. This shafting is driven direct by steam-engines, communicating motion to it by the means of pulleys and belts, while the shafts in turn drove the machines by belts and pulleys.

Factories set up in this way offered a view of shafting and pulleys and belting mingled in inextricable confusion overhead. Every installation of shafting can be divided into two very distinct parts:

Fig. 1.

1. Transmission shafts that run directly to the machinery.
2. Group of intermediate shafts, which are placed between the motors and the transmissions, properly so called, and which only serve to subdivide the work of the motor, modifying its speed and limiting the amount given to the pulleys, etc. This last group varies with the system of transmissions proposed. The first, on the other hand, is constant; whatever may be the system, it is the driving element. The use of systems of mechanical transmissions involve so many serious inconveniences, among which we may name the interdependence of all of the shafting of the shop, which does not allow one shaft to be stopped without stopping all the rest, that it is necessary to use expensive pieces of mechanism, whose action is not always certain. The solution of the problem becomes still more complicated if the industry to which it belongs is liable to numerous stoppages. Furthermore, the motor is compelled to drive a certain amount of dead weight, whereby it is necessary to overcome the inertia of the moving parts and friction resulting from any lack of lubrication. If only a small portion of the factory is in use, the utilization of the driving power is very bad. Another disadvantage lies in the difficulty, and sometimes in the impossibility of extending the plant. If we determine the effective output a system of transmitting relatively to the useful work which is performed and the work which is put into it, the difference between these two quantities is considered the loss—a loss which is inherent in every system of transmission. When power is transmitted by shafting, pulleys, gearing, belts, or ropes, the losses result from the friction of the shafting in their bearings, friction of the teeth of the gear-wheels, slipping of the belts, etc. It is generally admitted that these losses are almost the same whatever may be the amount of work transmitted, whether the shafting be driven empty or up to the full value of its possibilities.

In electrical transmission the losses are in two categories: one fixed, the other variable with the load. Fixed losses are, directly speaking, always constant, and are due to the exciting current and to the Foucault currents, to which it is well to add the friction of the shafting; the losses variable with the load are due to the resistance of the armature wiring. According to Joule's law, it is proportional to the resistance of these conductors and to the squares of the intensity of the current. The sum of these losses includes the energy absorbed in the machine, but all which it absorbs above this is integrally transformed. But when we consider the loss in the line of conductors which connect the dynamo with the motor, we are in possession of all the elements for calculating the efficiency for all transmissions under different loads. If we make this calculation of efficiency for a given system of transmission, first by mechanical processes and then by electrical, we will obtain very different results as the load diminishes. With one-fifth of the power developed, the electrical transmission has an efficiency of more than 40 per cent., while the efficiency of the other falls to nothing.

The question of the efficiency of loads less than the normal is a very important one, for experience teaches that a shop is rarely working under a full load—that is to say, it very rarely happens that all of the machines are working together, there are always a great number of stoppages, either for the workman to adjust his material, set up his machine, or for some other reason. In times of less activity, the number of idle machines increases still more. The power which is utilized grows gradually less in comparison to the great amount of energy absorbed by the system of transmission, and the consumption of coal is entirely out of proportion to the amount of useful work done. As a general thing, accurate ideas relative to the average amount of work absorbed in a shop are not very extensive. It is not infrequently the case that owners are in absolute ignorance in this regard. From a series of tests which have been undertaken, the details of which it is impossible for us to recapitulate here, we may say that the results given, time and again, show that the power required to drive the shafting of an idle shop is greater than that which is absorbed in work during average running. When we consider the small amount of motive power used in useful work at the machine, it is evident that time would be well spent in searching for some improvement in the method of transmis-

sion. In the particular case which we have in hand, besides the question of efficiency the following advantages, which are due to the electrical system of transmission of energy, occupy a prominent place :

1. Facility in arranging the machinery in the most convenient positions, and relatively to light and space. Absolute independence of each machine or room, and the possibility of regulating the speed at will.

2. Convenience in the fitting of the motors, by attaching them directly to the driving-shaft; inspection, starting, stopping, reduced to the narrowest limits.

3. Almost complete suppression of shafting and belts that are so cumbersome and expensive, besides serving as a constant menace to the safety of the operatives. The elimination of dust, and the blowing of it about in the air, due to the constant movements of the belts.

4. Another capital consideration in the mining regions of Saint-Étienne is that such movements of the earth are caused as throw shafting out of line, and result in a considerable increase of power consumed. If the relative position of all parts of a shop were rigidly fixed, this disadvantage would be done away with.

5. Finally, electric light having been decided upon, they considered the advisability of using the light dynamos for driving the motors, the expense of whose installation would not be very much in excess of what a system of shafting would amount to when used for operating shops at some distance from the source of power.

Messrs. Forrest & Co., after having carefully investigated all the advantages which the adoption of electricity seemed to show, decided to install such a system.

Fig. 2.

The electrical installation includes two tubular boilers which furnish steam, not only to the engine, but also to the general system of heating the shops, offices and storehouses. The steam-engine is a single-cylinder, horizontal, condensing engine with a variable cut-off, controlled by the governor, and developing about 120 H.P. The steam valve is driven by an eccentric rod, and the point of the attachment of the rod to the cut-off valve is movable on a hook, and can be set by hand or by the action of the governor. This engine drives the dynamos directly by means of a belt; these latter are located symmetrically, relative to the driving pulley. The two dynamos used are of the Sautter-Harlé type, having a capacity of 42,000 watts at 70 volts, while making 600 revolutions per minute. A single pulley set between double bearings drives them by means of a Raffard clutch. These two dynamos are wired, so that they may be used either for motive power or for lighting. Either one can be cut out by means of clutches. A large switchboard, about 13 ft. square, contains the usual supply of electrical measuring instruments and switches. Four sets of insulated cables run out from the dynamos, having a section of ½ sq. in. They pass underground into insulated passages, and come out on each side of the switchboard, and are connected with four large special bars, with the interposition of a bipolar cut-out, and from that point the two negative cables are connected together and are divided into six cables of proper size to serve as return conductors for different services of power and light, being run along the left side of the shop. The positive conductors at each dynamo unite in two circular concentric blocks of bronze; 14 small intermediate blocks are put in connection with them by means of binding screws, with a positive side of one or the other of the dynamos. The blocks are the starting-points for 14 lines of independent circuits which traverse the switchboard. All of these lines run along the right side of the shop. Such an arrangement does away entirely with all risks of short circuits between cables, which for the greater portion of their course are of naked copper attached to porcelain insulators, which facilitate the attachment of the circuits. The branches are made at right angles. All the ramifications are made by means of carefully insulated conductors. Two voltmeters and ampèremeters are in constant service on the switchboard. The regulation is controlled by the two rheostats mounted on marble, as are all the commutators, interrupters, and cut-outs.

A battery of 36 elements of Tudor accumulators, with a capacity of 200 ampère hours, feeds the lamps in the office and storehouse, when the engines are stopped; 50 arc lamps of 6 ampères each light the storehouse, the vestibule, the workrooms, and the machine shops; about 350 incandescent lamps are used for lighting the offices and shop, where each machine

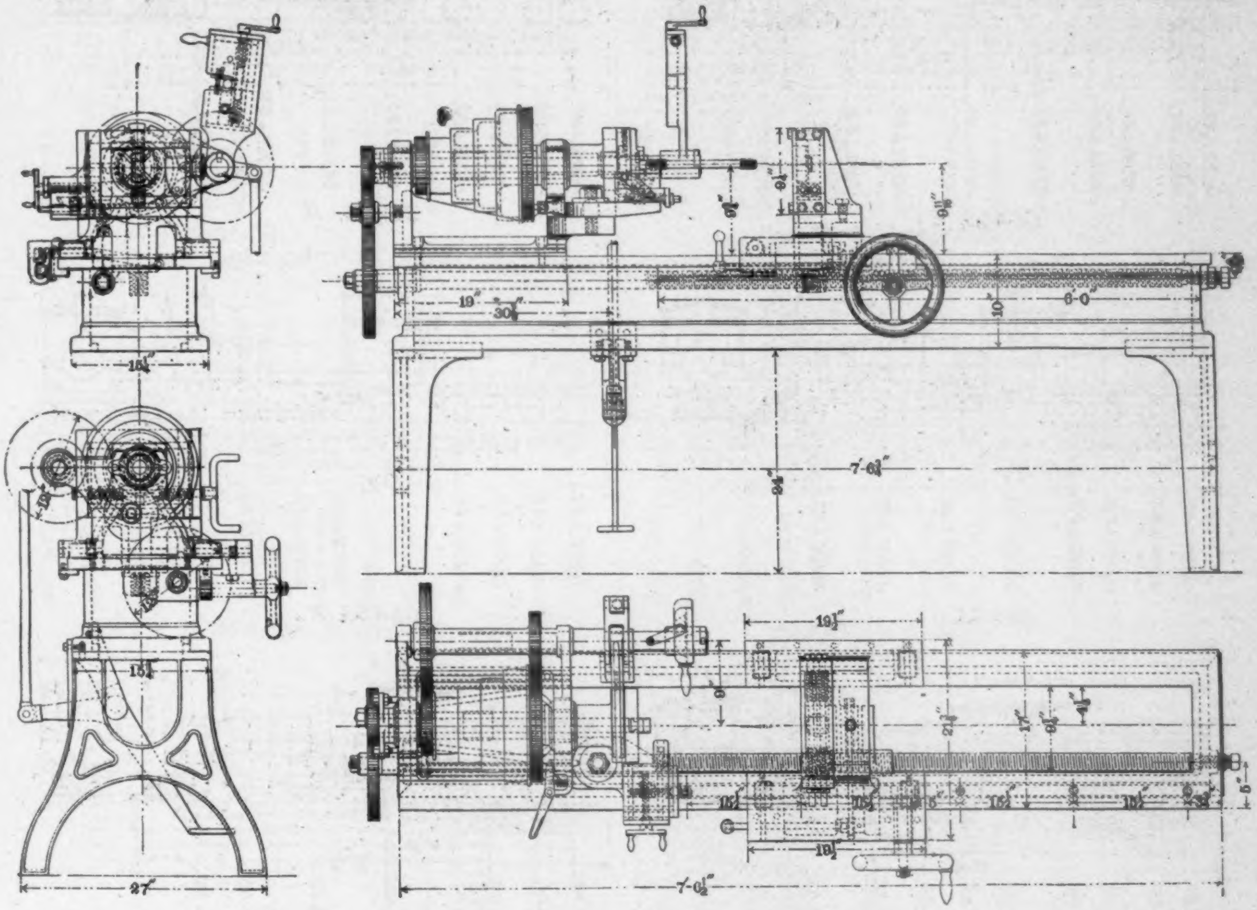
is provided with two lamps. After repeated experiments, electric motors of the Olivet-Dessauls system were adopted. The management have shown that they have an efficiency of not less than 55 per cent. for the 25 kilogrammeter (180 foot-pounds) machines. The speeds do not vary more than 10 per cent., which is a comparatively insignificant matter. Forty 75 kilogrammeter motors located in the weaving-room drive the looms by means of pulleys, as shown in fig. 1. The loose pulley, which permits the motor to continue running when the looms stop, consumes only one-fourth of the current which is absorbed by the full load. In a word, they require an output of from 5 to 10 ampères while running at a normal speed of from 800 to 900 revolutions per minute; when running blank they make 1,000 turns, consuming 2½ ampères, the current being only cut out for long stoppages. Sixty motors of the 25 kilogrammeter type are placed at the foot of the ribbon and velvet looms, as shown in fig. 2, and drive them by means of leather cords running on a double intermediate pulley fixed on one side above the motor; thence the power is directly transmitted to the loom itself. These motors consume, according to the load, from 2½ to 5 ampères, and their speed varies from 1,400 to 1,500 revolutions per minute.

Five motors, with a H.P. of from 1 to 3, control by means of light methods of transmission, the weaving-rooms, mechanical warping, cutting and glossing, the silk throwing and the spindles. Two very small motors of from 10 to 25 kilogrammeter capacity operate the printing-presses and cut off the lengths rolled upon the spools.

This is perhaps the most extensive application of individual driving of weaving machines for high-class fabrics that there is in the world, and it marks an interesting advance in the application of electricity as a motive power from a purely mechanical standpoint. The facts which the author has brought out, and saving in power when only a small portion of the machinery is in active operation, deserves the careful attention of all proprietors who contemplate erection of new shops, whether it is for metal working or for the manufacture of cloth. Freedom from dust due to the absence of pulleys and belting, which act like fans upon the whole surrounding atmosphere, is a matter of the utmost importance to the manufacturers of fine dress goods.

STAY-BOLT CUTTER IN THE PHILADELPHIA & READING RAILROAD SHOPS.

We have from time to time illustrated and described a number of tools that are in use in the shops of the Philadelphia & Reading Railroad, at Reading, Pa. Among the tools that have been designed and built upon the premises is the stay-bolt cutter that is illustrated by the accompanying engravings. The stay-bolts that are used in the boilers of this road have a hexagon head on the under side of the crown-sheet, are screwed through the sheets from the inside, and are kept tight by a copper washer under the head on the inside and by riveting over the projection of the bolt on the outside where it

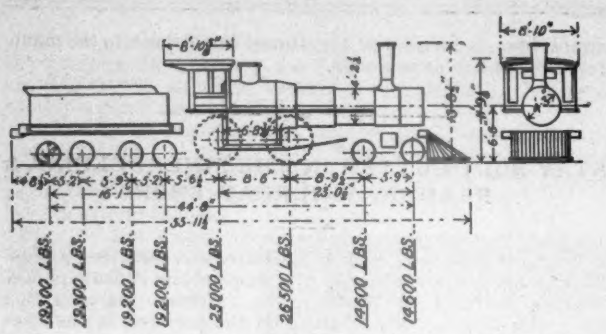


STAY-BOLT CUTTER IN THE PHILADELPHIA & READING RAILROAD SHOPS.

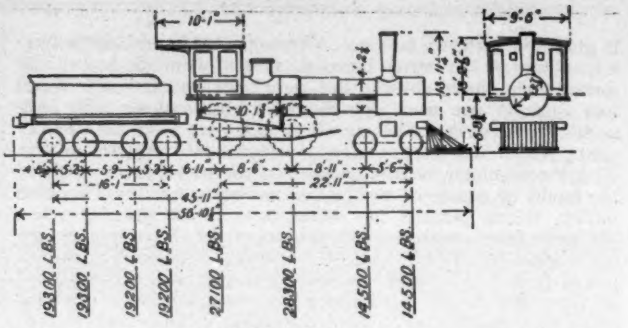
comes through the sheet. It is, therefore, necessary that the thread on the bolt should be cut clear up to the under side of the head, and that the latter should be faced off for a smooth and even bearing on the head. Then, to avoid the loss of time and the wearing of the threads incident to the screwing of a long bolt through the sheet, the thread is cut away between the working points, as shown on the bolt that is in position on the machine. The thread is cut for the whole length of the bolt, and the die is followed by a tool that removes the thread.

In general appearance this machine resembles a light lathe rather than the usual type of bolt cutter. The thread on the bolt is cut by open dies on the carriage, and in order to take the strain off from the thread and dies while the work is being done, the carriage is fed by a lead screw driven by the gearing shown at the end of the headstock. The tool for removing the threads is back of the dies, and is fed in against a stop, so that it just faces off down to the bottom of the threads. Attached to the headstock is a carriage with a cross-feed that

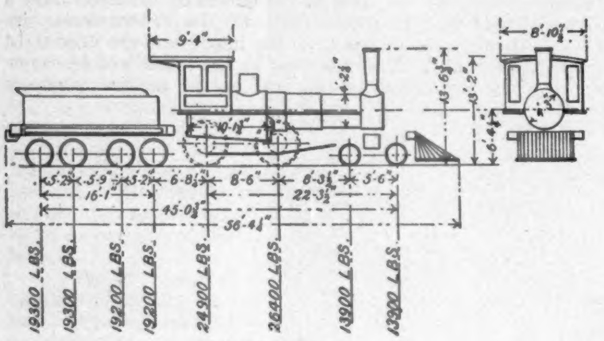
CLASS. A.
(51 to 70)



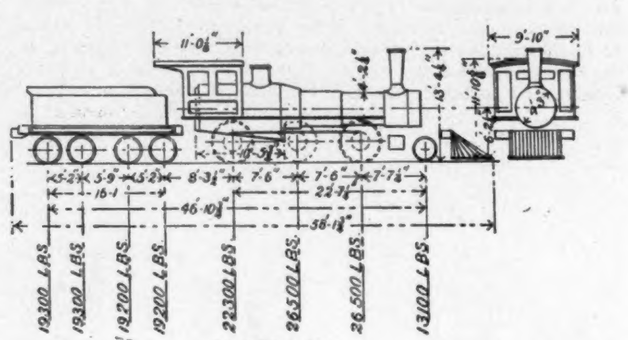
CLASS. A.
(80 ETC)



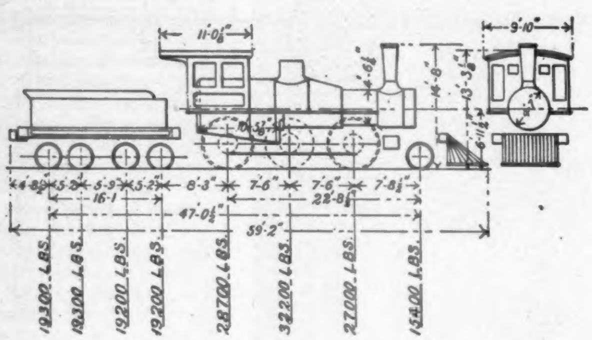
CLASS. B.



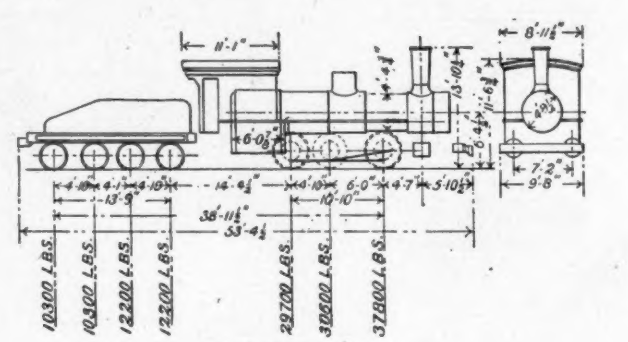
CLASS D.



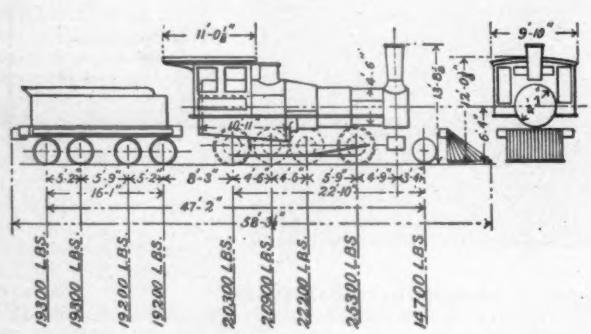
CLASS. E.



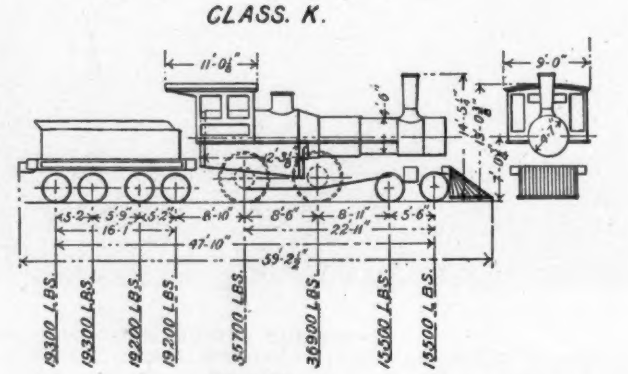
CLASS. H.



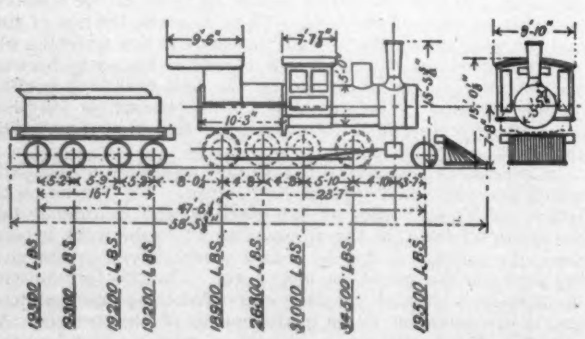
CLASS.



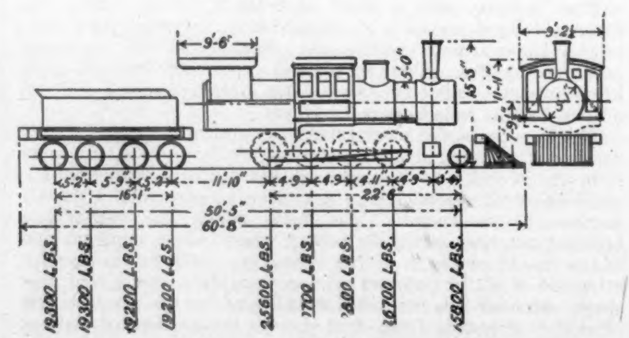
CLASS. K.



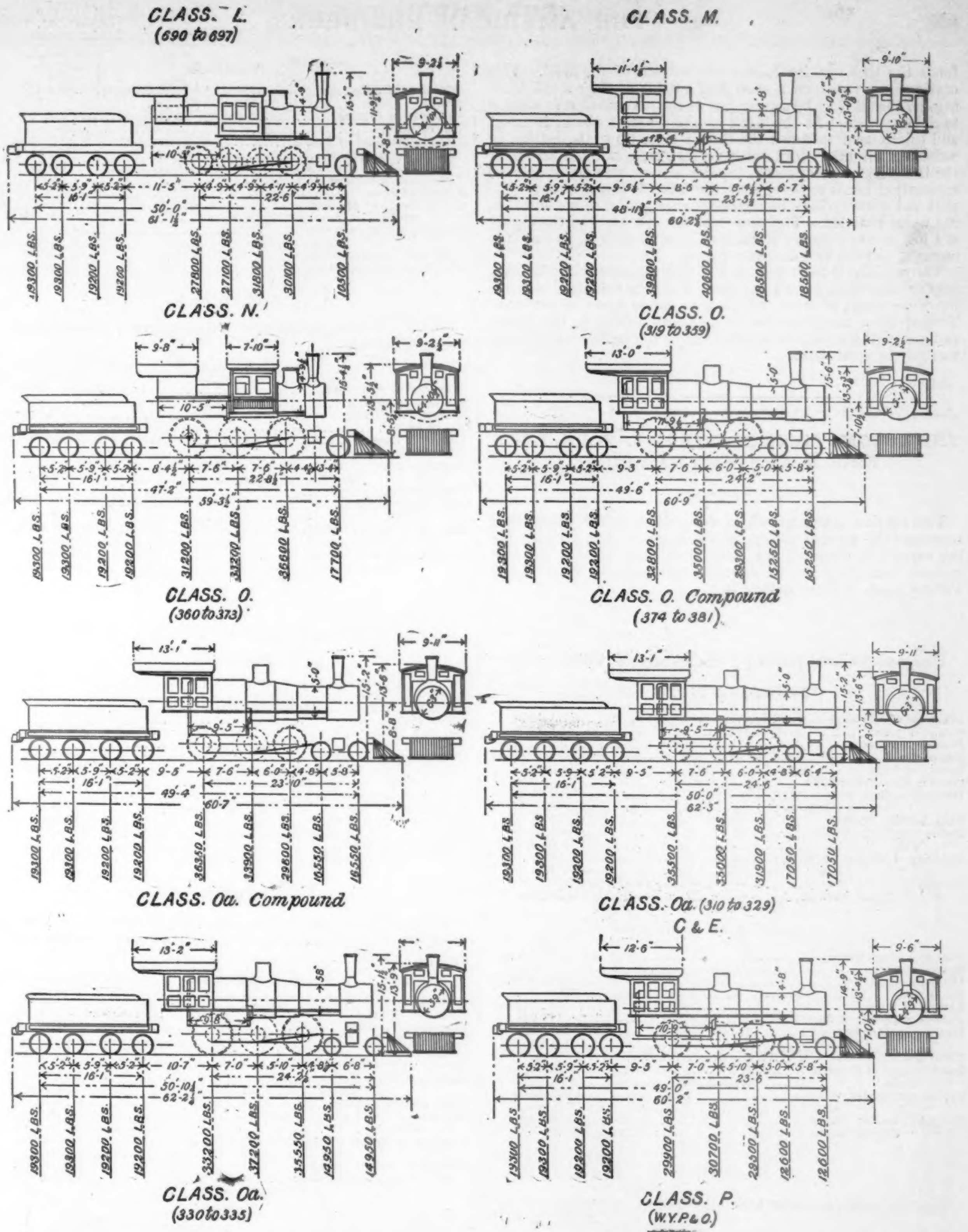
CLASS. L.
(698 to 722)



CLASS. L.
(723 to 747)



OUTLINES OF STANDARD LOCOMOTIVES ON THE NEW YORK, LAKE ERIE & WESTERN RAILROAD.



OUTLINES OF STANDARD LOCOMOTIVES OF THE NEW YORK, LAKE ERIE & WESTERN RAILROAD.

feeds the tool out for facing the bottom of the head. This carriage is pivoted on a stud just outside of the spindle bearing, so that it may be swung out of the way until it is wanted to do its work. At the back of the frame a chaser is hung, and this is used to finish the thread close up to the head. In order that it may work with perfect ease and not endanger the integrity of the threads, the connection between it and the supporting bar is so loose that the latter becomes a mere support and entirely loses its character as a guide, as we find it in the usual practice. The play between the bar and the chaser is $\frac{1}{4}$ in., or even more; it matters little what it is, so that it is enough, and the two cannot separate.

The machine is back-geared, and this, together with the four-step driving cone, gives a variation of speeds sufficient to cover the wide range of work which it is called upon to perform. Two of these machines are in constant service in the shops, and are giving excellent satisfaction in the rapid and accurate work done upon them.

THE LOCOMOTIVES OF THE NEW YORK, LAKE ERIE & WESTERN RAILROAD.

The outline diagrams which we publish in this connection represent the several classes of locomotives that are used for the various services on the New York, Lake Erie & Western system, including the Chicago & Erie and the New York, Pennsylvania & Ohio Railroads.

CLASS A.

Designed for local passenger service of short trains.

DIMENSIONS OF 51 TO 70.

Diameter of cylinders	18 in.
Stroke of piston	22 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	168
Length of flues	11 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,003 sq. ft.
" " fire-box	106 sq. ft.
Total heating surface	1,109 ft.
Inside length of fire-box	6 ft. $\frac{3}{16}$ in.
" width " "	2 ft. $9\frac{5}{8}$ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	80,200 lbs.

DIMENSIONS OF 80, ETC.

Diameter of cylinders	18 in.
Stroke of piston	22 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	157
Length of flues	11 ft. $5\frac{15}{16}$ in.
Outside diameter of flues	2 in.
Heating surface flues	938.5 sq. ft.
" " fire-box	114.5 sq. ft.
Total heating surface	1,053 sq. ft.
Inside length of fire-box	9 ft. $5\frac{1}{4}$ in.
" width " "	2 ft. $9\frac{1}{8}$ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	84,700 lbs.

CLASS B.

Used on local passenger and light freight.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	22 in.
Diameter of drivers	5 ft. 2 in.
No. of flues	157
Length of flues	11 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	938.5 sq. ft.
" " fire-box	114.5 sq. ft.
Total heating surface	1,053 sq. ft.
Inside length of fire-box	9 ft. $5\frac{1}{4}$ in.
" width " "	2 ft. $9\frac{1}{8}$ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	79,100 lbs.

CLASS D.

For local freight traffic.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 8 in.
No. of flues	168
Outside diameter of flues	2 in.
Heating surface, flues	1,029 sq. ft.
" " fire-box	120 sq. ft.
Total heating surface	1,149 sq. ft.
Length of flues	11 ft. $8\frac{1}{8}$ in.
Inside length of fire-box	9 ft. $9\frac{3}{16}$ in.
" width " "	2 ft. $9\frac{1}{8}$ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
Weight of engine, loaded	88,400 lbs.

CLASS E.

Mogul for heavy passenger trains carrying commuters and for milk service.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	213
Length of flues	11 ft. $8\frac{1}{8}$ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,296.5 sq. ft.
" " fire-box	152.5 sq. ft.
Total heating surface	1,449 sq. ft.
Inside length of fire-box	9 ft. $8\frac{13}{16}$ in.
" width " "	2 ft. $9\frac{1}{8}$ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	103,300 lbs.

CLASS H.

General switching service, both passenger and freight.

DIMENSIONS.

Diameter of cylinders	19 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	122
Length of flues	14 ft. $9\frac{1}{8}$ in.
Outside of flues	$2\frac{1}{2}$ in.
Heating surface, flues	1,174 sq. ft.
Inside length of fire-box	5 ft. $3\frac{3}{16}$ in.
" width " "	2 ft. $10\frac{1}{8}$ in.
Heating surface, fire-box	100 sq. ft.
Total heating surface	1,274 sq. ft.
Capacity of tender, water	2,400 galls.
" " " coal	3 tons.
Weight of tender, empty	20,000 lbs.
" " engine, loaded	98,100 lbs.

CLASS I.

Originally designed for through freight, but is now used on heavy local freight and pick-ups, while some of the class are in switching service.

DIMENSIONS.

Diameter of cylinders	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	200
Length of flues	11 ft. $4\frac{1}{2}$ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,182.5 sq. ft.
" " fire-box	140.5 sq. ft.
Total heating surface	1,323 sq. ft.
Inside length of fire-box	10 ft. $2\frac{3}{16}$ in.
" width " "	2 ft. 9 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	103,400 lbs.

CLASS K.

Heavy commuters, trains, through local expresses, such as are run on the Northern Railroad of New Jersey; also used for division work in express service.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	22 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	225
Length of flues	11 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,345 sq. ft.
" " fire-box	158 sq. ft.
Total heating surface	1,503 sq. ft.
Inside length of fire-box	11 ft. $6\frac{3}{16}$ in.
" width " "	2 ft. $8\frac{7}{8}$ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	103,600 lbs.

CLASS L.

A Wootten consolidation for freight service.

DIMENSIONS 698 TO 722.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	235
Length of flues	11 ft. 10⅜ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,584 sq. ft.
" " fire-box	174 sq. ft.
Total heating surface	1,758 sq. ft.
Inside length of fire-box	9 ft. 6 5/12 in.
" width of fire-box	8 ft.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of " empty	32,800 lbs.
" " engine, loaded	130 200 lbs.

DIMENSIONS 723 TO 747.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	206
Length of flues	11 ft. 2¼ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,206.5 sq. ft.
" " fire-box	161.5 sq. ft.
Total heating surface (including combustion chamber)	1,416.5 sq. ft.
Inside length of fire-box	9 ft. 6 in.
" width " "	8 ft. 2⅛ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	131,600 lbs.

DIMENSIONS 690 TO 697.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	204
Length of flues	11 ft. 2¼ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,195 sq. ft.
" " fire-box	160 sq. ft.
Total heating surface (including combustion chamber)	1,403.5 sq. ft.
Inside length of fire-box	9 ft. 6 in.
" width " "	8 ft. ½ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	127,300 lbs.

CLASS M.

For heavy commuters' trains and through passenger service.

DIMENSIONS.

Diameter of cylinder	19 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	246
Length of flues	11 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,470.5 sq. ft.
" " fire-box	160.5 sq. ft.
Total heating surface	1,631 sq. ft.
Inside length of fire-box	11 ft. 6 3/16 in.
" width " "	3 ft. 5⅝ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	117,400 lbs.

CLASS N.

Through passenger traffic.

DIMENSIONS.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	336
Length of flues	9 ft. 5⅜ in.
Outside diameter of flues	1½ in.
Heating surface, flues	1,241 sq. ft.
" " fire-box	181 sq. ft.
Total heating surface (including combustion chamber)	1,458.5 sq. ft.
Inside length of fire-box	9 ft. 6 in.
" width " "	8 ft. ¼ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	118,700 lbs.

CLASS O.

Through freight and passenger on light and level divisions.

DIMENSIONS 319 TO 359.

Diameter of cylinders	20 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 8 in.
No. of flues	275
Length of flues	13 ft. 2 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,895.9 sq. ft.
" " fire-box	171 sq. ft.
Total heating surface	2,066.9 sq. ft.
Inside length of fire-box	11 ft. 7/16 in.
" width " "	3 ft. 7 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	127,600 lbs.

DIMENSIONS 360 TO 370.

Diameter of cylinder	20 in.
Stroke of piston	24 in.
Diameter of drivers	62 in.
No. of flues	263
Length of flues	13 ft. 2 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,813 sq. ft.
" " fire-box	177 sq. ft.
Total heating surface	1,990 sq. ft.
Inside length of fire-box	8 ft. 8 in.
" width " "	42⅝ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	132,950 lbs.

CLASS O (COMPOUND).

Same service as the simple engines.

DIMENSIONS.

Diameter of cylinder	14 and 24 ins
Stroke of piston	24 in.
Diameter of drivers	62 in.
No. of flues	263
Length of flues	13 ft. 2 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,813 sq. ft.
" " fire-box	177 sq. ft.
Total heating surface	1,990 sq. ft.
Inside length of fire-box	8 ft. 8 in.
" width " "	42⅝ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	136,500 lbs.

CLASS O*a* (COMPOUND).

Through passenger and freight service on the Chicago & Erie Railroad.

DIMENSIONS.

Diameter of cylinder	14½ in. and 25 in.
Stroke of piston	24 in.
Diameter of drivers	68 in.
No. of flues	213
Length of flues	13 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,505.6 sq. ft.
" " fire-box	156.3 sq. ft.
Total heating surface	1,661.9 sq. ft.
Inside length of fire-box	9 ft.
" width " "	32 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	135,850 lbs.

CLASS O*a*.

Same service on Chicago & Erie Railroad.

DIMENSIONS.

Diameter of cylinders	19 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 2 in.
No. of flues	195
Length of flues	13 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,378.37 sq. ft.
" " fire-box	166.88 sq. ft.
Total heating surface	1,545.25 sq. ft.
Inside length of fire-box	10 ft.
" width " "	2 ft. 9⅜ in
Capacity of tender, water	3,600 galls
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	115,300 lbs.

DIMENSIONS 330 TO 335.

Diameter of cylinders	19 in.
Stroke of piston	24 in.
Diameter of drivers	62 in.
No. of flues	213
Length of flues	13 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,505.6 sq. ft.
" " fire-box	156.3 sq. ft.
Total heating surface	1,661.9 sq. ft.
Inside length of fire-box	9 ft.
" width " "	32 in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	127,200 lbs.

CLASS P.

Through freight service on the New York, Pennsylvania & Ohio Railroad.

DIMENSIONS.

Diameter of cylinders	20 in.
Stroke of piston	24 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	239
Length of flues	11 ft. 5⅝ in.
Outside diameter of flues	2 in.
Heating surface, flues	1,424.75 sq. ft.
" " fire-box	188.75 sq. ft.
Total heating surface	1,613.5 sq. ft.
Inside length of fire-box	11 ft. 6 3/16 in.
" width " "	3 ft. 5⅛ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	131,150 lbs.

CLASS Q.

Through passenger service on the New York, Pennsylvania & Ohio Railroad.

DIMENSIONS.

Diameter of cylinders	18 in.
Stroke of piston	24 in.
Diameter of drivers	5 ft. 2 in.
No. of flues	221
Length of flues	12 ft. 6 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,321 sq. ft.
" " fire-box	132 sq. ft.
Total heating surface	1,453 sq. ft.
Inside length of fire-box	5 ft. 11 11/16 in.
" width " "	2 ft. 10⅛ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	106,600 lbs.

CLASS R.

Fast freight.

DIMENSIONS.

Diameter of cylinders	21 in.
Stroke of piston	26 in.
Diameter of drivers	5 ft. 2 in.
No. of flues	258
Length of flues	10 ft. 10 in.
Outside diameter of flues	2 in.
Heating surface, flues	1,480 sq. ft.
" " fire-box	156.5 sq. ft.
Total heating surface (including combustion chamber)	1,699 sq. ft.
Inside length of fire-box	9 ft. 5 13/16 in.
" width " "	8 ft. 2⅛ in.
Capacity of tender, water	3,600 galls.
" " " coal	8.9 tons.
Weight of tender, empty	32,800 lbs.
" " engine, loaded	138,100 lbs.

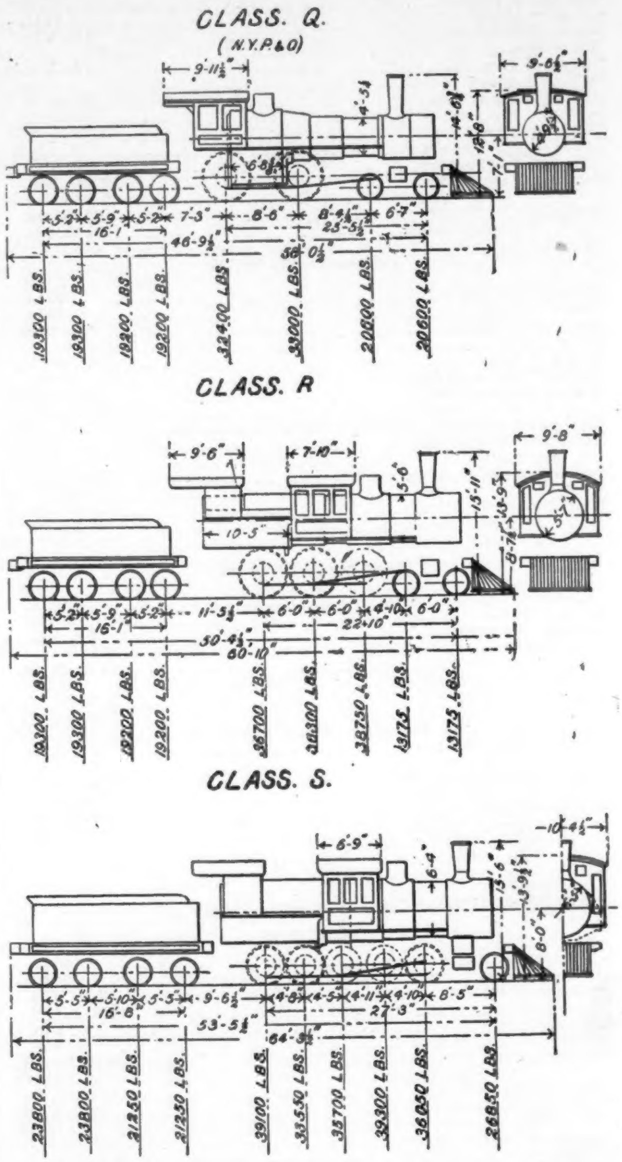
CLASS S (COMPOUND).

Heavy pushers.

DIMENSIONS.

Diameter of cylinders	16 & 27 in.
Stroke of pistons	28 in.
Diameter of drivers	4 ft. 2 in.
No. of flues	354
Length of flues	12 ft. ¼ in.
Outside diameter of flues	2 in.
Heating surface, flues	2,213 sq. ft.
" " fire-box	179 sq. ft.
" " combustion chamber	48.5 sq. ft.
Total heating surface	2,440.5 sq. ft.
Inside length of fire-box	10 ft. 11⅜ in.
" width " "	8 ft. 2⅛ in.
Capacity of tender, water	4,500 galls.
" " " coal	10 tons.
Weight of tender, empty	
" " engine, loaded	200,550 lbs.

An interesting feature of this classification of locomotives is the absence of all cylinders of less than 18 in. in diameter. Even for the light passenger traffic, where probably not more than four or five cars are hauled in a train, the cylinder diameters are kept up to these dimensions. A man need not be so very old to remember when 16 in. was the standard diameter for the large engines on through trunk lines handling a heavy traffic. With cylinder diameters increased the heating surface has also arisen, though perhaps not in the same proportions. Class A, for example, with 18-in. cylinders, has a total heating surface of only 1,109 sq. ft., while even more than this has frequently been given for 16-in. cylinders doing the same class of work, while the second division of Class A and Class B have only 1,053 sq. ft. But when we consider the heating surface of 2,066.9 sq. ft., that is obtained on Class O, it is amusing to remember the struggles with the 16-in. engines, when attempts were being made to raise the heating surface to 1,300 sq. ft. Equally significant is the tremendous weight that is now put upon drivers. The 40,600 lbs. that is put upon the forward pair of drivers of Class M would have been considered impossible but a few years ago. It is such work as this that causes the triangular contest between the operating, road and motive power departments. The Operating De-



STANDARD LOCOMOTIVE OUTLINES N. Y., L. E. & W. R. R.

partment calls upon the Superintendent of Motive Power to haul heavier trains; the latter tells the chief engineer to strengthen his bridges, and the engineer protests that he must have more metal if he is to do it. The opinion seems to prevail in some quarters, however, that the limit is nearly reached, as trains are about as long as it is safe to haul.

PROCEEDINGS OF SOCIETIES.

New York Railroad Club.—The regular monthly meeting was held on the evening of November 16, at which time the annual election took place, resulting in the election of George W. West, Superintendent of Motive Power of the New York, Ontario & Western Railway, as President; of A. E. Mitchell, Superintendent of Motive Power of the New York, Lake Erie & Western Railroad, as First Vice-President, and W. H. Lewis, Master Mechanic of the Delaware, Lackawanna & Western Railroad, as Second Vice-President. At the October meeting the position of Secretary was made an appointive office under the direction of the executive committee. Previous to the election of officers, Mr. R. H. Parks read an exceedingly interesting paper on the use of compressed air for shop purposes.

American Railway Master Mechanics' Association.—The joint circulars of the Master Mechanics' and the Master Car-Builders' Associations have been issued by their respective secretaries, and announce that the Master Car-Builders and the Master Mechanics have decided on the Thousand Islands, at Alexandria Bay, for the place of their next meeting in June, 1895. The committee have made the following arrangements with Mr. J. B. Wister, proprietor of the Thousand Island House, Thousand Islands, Alexandria Bay, N. Y., and Mr. Charles W. Crossmon, proprietor of the Crossmon House, Thousand Islands, Alexandria Bay, N. Y., as to terms, as follows: Single rooms, with board, $3 per day each person; single rooms, with board and bath, $4 per day each person; double rooms, with two persons, $3 per day each person. These rates are to members of the Association and their friends. Applications for rooms should be made to Mr. J. B. Wister, proprietor of the Thousand Island House, Thousand Islands, Alexandria Bay, N. Y., and Mr. Charles W. Crossmon, proprietor of the Crossmon House, Thousand Islands, Alexandria Bay, N. Y. The committee request that members will apply at once for rooms, as those who first apply will be best served.

Engineers' Club of St. Louis.—At a meeting held November 7, Professor H. A. Wheeler read a paper on The Merz Process of Handling Garbage at the South St. Louis Works.

Previous to 1891 the garbage had been dumped in the river, the quantity then being estimated at 40 tons per day. It now averages 150 tons daily, and has reached 300 on Mondays during the watermelon season, the daily quantity per capita varying between ½ and 1 lb. All garbage is now reduced by the St. Louis Sanitary Company, the city paying them 9 cents per pound up to 200 tons daily, above which quantity it is reduced free of charge. The upper, or No. 1 plant, built 4 years ago, was originally of 40 tons capacity; it was later increased to 75 tons, and last summer handled as high as 100 tons. The No. 2 plant, at the foot of Chouteau Avenue, was only temporary, and has been abandoned. The No. 3 plant is located at the foot of Montana Street, in South St. Louis, and began operations in the spring of 1894. Its daily capacity is 200 tons. Professor Wheeler explained in detail the system employed, devoting special attention to the methods of ventilation. In his opinion the plant was of great interest to engineers, and deserved the good opinion of the profession as representing an intelligent effort in the direction of a solution of a most difficult problem.

American National Association of Railway Superintendents of Bridges and Buildings.—The fourth annual meeting was held at Kansas City, Mo., October 16–19. The subjects upon which reports were received and discussed were: Depressed Cinder Pits; the Best Method of Bridge Inspection; Maintenance of Pile and Frame Trestles; and the Best Scale Foundation. The next meeting is to be held on the third Tuesday of October, 1895, at Atlanta, Ga., where the subjects of papers to be read and discussed will be as follows: Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges; Methods and Special Appliances for Building Temporary Trestles over Wash-outs and Burn-outs; Strength of Various Kinds of Timber used in Trestles and Bridges, Especially with Reference to Southern Yellow Pine, White Pine, Fir and Oak; Best Method of Erecting Plate Girder Bridges; Best and Most Economical Railway Track Pile Driver; Sand Dryers, Elevators and Methods of Supplying Sand to Engines, Including Buildings; Span Limits for Different Classes of Iron Bridges and Comparative Merits of Plate Girder and Lattice Bridges for Spans from 50 ft. to 110 ft.; Best Method of Spanning Openings too Large for Box Culverts, and in Embankments too Low for Arch Culverts; Best End Construction for Trestles Adjoining Embankments; Interlocking Signals; Pumps and Boilers.

Society of Naval Architects and Marine Engineers.—The annual meeting was held at the house of the American Society of Mechanical Engineers on Thursday and Friday, November 15 and 16. In another column we reprint the main portion of the paper by Commodore George W. Melville, and regret that lack of space prevents a more elaborate review of the proceedings. The following is a list of the papers that were read: Some Suggestions of Professional Experience in Connection with the Naval Construction of the last Ten Years—1884–1894, by Richard W. Meade, Rear-Admiral, U. S. Navy; The Use of Small Models for the Determination of Curves of Stability, by E. Bertin, Director of the French Government School of Naval Design; Some Obstacles to Ship-Building and Owning in this Country, by George W. Dickie, Esq., Naval Architect, San Francisco, Cal.; Present Status of Face-Hardened Armor, by W. T. Sampson, Captain and Chief of Ordnance, U. S. Navy; Cellulose and its Application to Warships, by E. Cheneau, Philadelphia, Pa.; Experience Gained with our New Steel Ships as Regards Care and Preservation, by Philip Hichborn, Chief Constructor, U. S. Navy; The U. S. Triple-screw Cruisers *Columbia* and *Minneapolis*, by George W. Melville, Engineer-in-Chief, U. S. Navy; Electricity on Shipboard: its Present Position and Future Development, by S. Dana Greene, Esq., New York, N. Y.; Hydraulic Power for Warships, by Albert W. Stahl, Naval Constructor, U. S. Navy; Yachts in England and America, by Lewis Nixon, Esq., Naval Architect, Philadelphia, Pa.; A Dynamic Steam Engine Indicator Tester, by Professor Cecil H. Peabody and Assistant Professor E. F. Miller, Massachusetts Institute of Technology; An Approximate Formula for the Wetted Surface of Ships, by W. F. Durant and G. R. McDermott; Notes on Launching, by William J. Baxter, Naval Constructor, U. S. Navy; Accessibility and Circulation of Water-tube Boilers, by L. D. Davis, Esq., M.E., Erie, Pa.; Recent Light-draft Gunboats of the U. S. Navy, by J. J. Woodward, Naval Constructor, U. S. Navy.

Master Car-Builders' Association.—The Secretary has recently sent out the following circular relative to the standards that have been adopted by the Association:

"Replies to circular dated September 4, in regard to gauges recently adopted by the Association, do not indicate that orders for 50 sets can be assured at the prices quoted by gauge manufacturers. Many of the replies indicate that the prices quoted are considered too high, and that gauges have been or will be made by the companies at their own shops. The Executive Committee has again considered the question, and decided that it cannot effect satisfactory arrangements with gauge manufacturers for these gauges. It recommends that railroad companies making these gauges should have the large lithograph drawings of same from this office, so that the gauges may be properly made in so far as the essential or gauging dimensions are concerned.

"The Executive Committee has examined the 15 sheets of lithograph drawings showing all the standards and recommended practice revised to date—that is, including changes and new matter since the ballot of 1894—and believes that members do not fully appreciate the importance of having a full set of these drawings for reference in following M. C. B. standards as thoroughly as possible. The Secretary has, therefore, been instructed to call attention again to this matter, as coming from the Executive Committee with its recommendation as above.

"When originally issued in 1893 there were sheets 1 to 11, inclusive, of M. C. B. standards, and sheets A and B of recommended practice. By the ballot of 1894 sheets 1, 2, 3, 8 and A were revised, and sheets 12 and C were originally issued, so that we now have sheets 1 to 12, inclusive, of M. C. B. standards, and sheets A, B and C of recommended practice, all as revised and completed to date.

"The new sheets of 1894, Nos. 12 and C, are as follows: Sheet 12 - Standard Terms and Gauging Points for Wheels and Track; Guard Rail and Frog Wing Gauge; Check Gauge for Mounting Wheels; Wheel Tread; Flange Thickness Gauges for New Wheels. Sheets C—Recommended Practice for Journal Bearing and Wedge Gauges; Safety Chains for Freight Cars; Minimum Thickness of Steel Tires; Dummy Coupling Hook. These lithographs are made on thin semi-transparent paper, so that blue prints may be taken therefrom the same as from tracings. They are sold at 25 cents per copy, or $3.75 for a set of 15 sheets."

Universal Exposition at Amsterdam, 1895.—We are in receipt of a circular dated at Amsterdam, announcing that a universal exposition will be held in that city under the patronage of Her Majesty the Queen Regent of the Netherlands, from May 1 to November 1, 1895. It is announced that the Exposition building, with its extensions, will cover 47,800 sq. yds., built of iron and sheathed in durable materials. The length of the main gallery will be 3,900 ft., and the height 46 ft. and the breadth 82 ft. In front of the monumental façade, having the breadth of 737 ft., there will extend 16 hectares (acres) of gardens and lawns for the exhibition of trees and plants. The present address is at 50 Marche St. Jacque, Antwerp, Belgium.

Discussing Aerial Locomotion.—At the meeting of the German Congress of Natural Science held in Vienna in September, Professor Boltomann delivered an interesting lecture on aerial locomotion. He predicted the greatest success for the application of aeroplanes in which the principle of an oblique plane is employed. He referred to Maxim's machine as a second step in advance.

PERSONAL.

Charles A. Sheldon, a graduate of Yale, and until recently Assistant Division Superintendent on the Michigan Division of the Lake Shore Railroad, has resigned that position and made an engagement with the Consolidated Company, and will have charge of the compressed gas-lighting department. That company is about to introduce the Pope system, which will be interchangeable with the Pintsch system.

Manufactures.

BAND RE-SAWING MACHINE.

We illustrate herewith a new band re-sawing machine which has been produced by the manufacturers to fill the wants of cabinet-makers, coach-builders, sash-and door manufacturers and all others where the requirements are for both re-sawing and hand or scroll work.

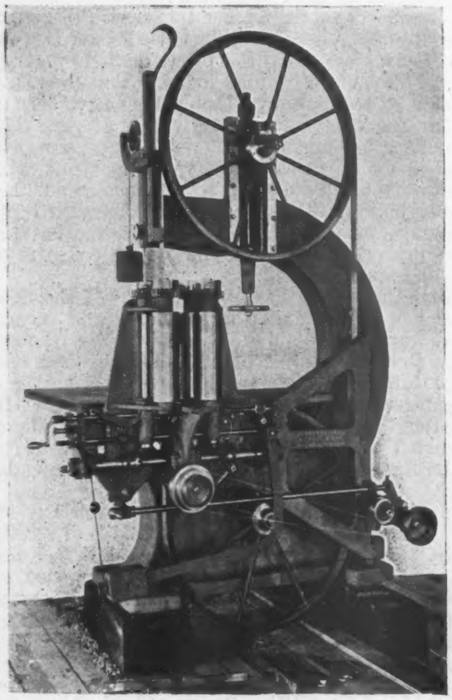


Fig. 1.

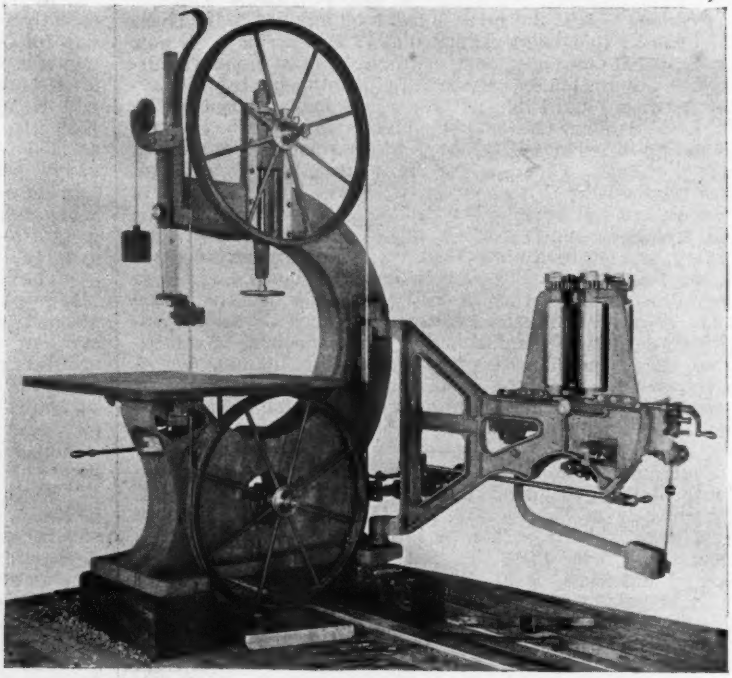


Fig. 2.

BERRY & ORTON COMPANY'S BAND RE-SAWING MACHINE.

This is a powerful machine, weighing over 4,000 lbs., and is so arranged that in re-sawing, the feed works are swung into their place and fastened by a single nut; there being no belts to take off or parts to disconnect, the operation consumes less than one minute. When the machine is to be used for plain or scroll sawing, the arms carrying the feed works are swung open, as is shown by the illustration, fig. 2.

The feed rollers are strongly geared, and will automatically center the material to be sawn, or they can be set so as to slab from one side of a timber by simply loosening one nut and tightening another. The rollers are set for different thicknesses of material by means of the crank shown at the left, near the table, and will also tip for sawing bevel siding or other work that may be needed. They are started and stopped independently of the machine, or the feed can be instantly stopped by raising the weight lever shown in front. The feed has three changes.

The machine will take lumber 22 in. wide and up to 8 in. thickness, and will carry saws 3¼ in. wide and less down to saws for the finest scroll work. The latest improved roller guides are supplied, the top one being counterweighted to prevent accidents by falling on the work.

These machines are built in five different sizes, weighing from 3,000 lbs. up to 12,000 lbs., carrying saws from 2 in. to 8 in. wide, being the largest line made in the country, filling the requirements of any work that may be needed of them.

For further information concerning the above, address the manufacturers, Berry & Orton Company, Twenty-third and Arch streets, Philadelphia, Pa.

THE FINLAYSON WATER-TUBE BOILER.

The interest centering in the use of water-tube boilers, both for stationary and marine water, which was so plainly evidenced at the meeting of the members of the American Society of Mechanical Engineers last spring, and reported in The American Engineer for June, is evidently not confined to this country. On page 547 of this issue we publish a translation of a very interesting paper on water-tube boilers, which was recently read before a German engineering society, in which a number of various types of water-tube boilers were described and discussed. Among the boilers which have recently been brought to the attention of the public in this country is the Finlayson boiler, manufactured by the Finlayson Boiler Company, Limited, of Detroit, Mich., of which we give two illustrations. The principle of the operation of this boiler is that the circulation of water shall be maintained in vertical directions, and that after the liberation of the steam from the water it shall be thereafter superheated before being used in the engine, while the waste products of combustion are utilized, as far as possible, with the feed water before it is delivered to the boiler itself. In order to utilize all the space surrounding the boiler to as great an extent as possible the front and back heads, instead of being lined up with fire-brick or other non-conducting material, are formed of water legs with flat surfaces and held together by stay-bolts after the manner of the water legs of locomotive boilers. At the bottom and out toward the sides these water legs are attached to each other by a large pipe, which is known as the side-flow pipe. At the top they are connected by the steam drum, to which direct access is obtained by means of the hand-hole plate, shown at the front of the engraving.

This steam drum naturally varies in the size with that of the boiler, but it is intended to be so designed that the steam space shall be ten times the capacity of the engine cylinder. This drum is kept half full of water, and as the outer surfaces of the water legs are naturally cooler than the inner surfaces, the flow of the water takes place from the drum down the outside portion of the water legs into the side flow pipes, and thence up through the circulating pipes, back through the drum. The distance which the water is obliged to traverse through

these smaller vertical pipes, which are used for heating purposes, is quite short, being from 2 ft. to 3 ft., depending on the size of the boiler.

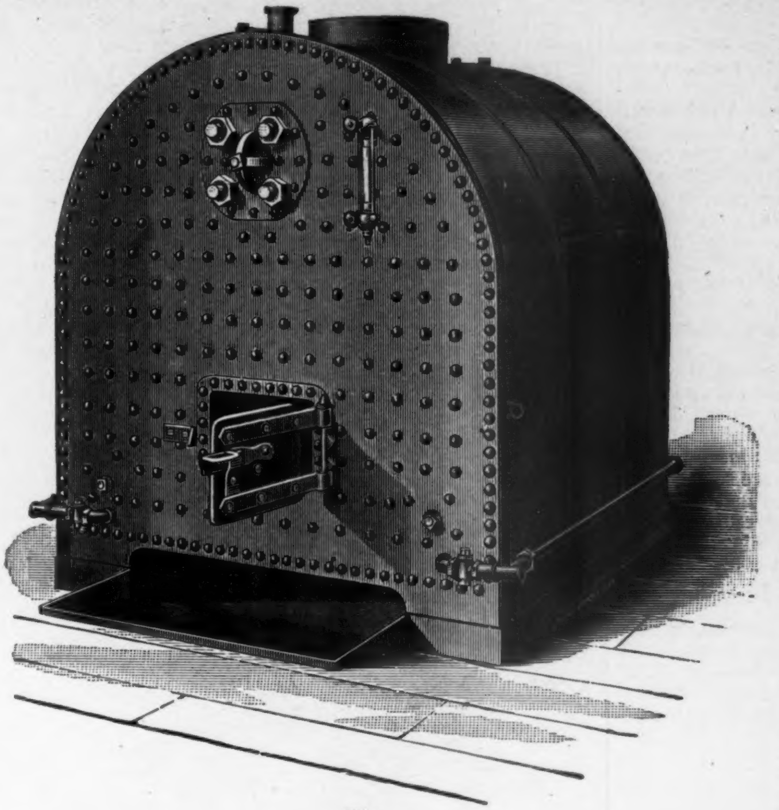


Fig. 1.

BOILER COMPLETE, EXCEPTING SUPERHEATING COILS AND SIDE-CASING, SHOWING SIDE FLOW PIPES, STEAM DRUM, ARRANGEMENT OF STEAM-GENERATING LOOPS AND FEED-WATER COILS.

In order to obtain the superheating to which reference has already been made, the coils are placed on either side of the boiler in such a position that they receive the heat which passes between the side flow pipes. The arrangement of these pipes is also different from anything else which we have thus far seen; instead of having the superheating pipes in one continuous coil, through the whole length of which all of the steam must pass, these are made in short lengths, with manifold connections both at top and bottom. Steam on leaving the drum does so through a perforated dry pipe lying along the upper side, thence comes downward toward the lower connection of these superheating pipes, and is distributed through them, rising again to the main supply pipe to the engine. Thus any water which may pass over through the steam drum into these pipes is not carried on to the engine cylinder, because the area of the upright pipes in the manifold is about fifteen times as much as that of the main steam pipe, so that there is no driving rush of steam through any one of them tending entrain water.

Blow-off pipes are placed at each lower corner of the water legs, through which the boiler can be readily washed out and the sediment, which would naturally collect at these points, be easily removed.

The feed-water coils are placed above the steam-generating section in a horizontal position, as shown in fig. 2, and the feed water is then carried back and through them until the boiling point is reached, when it is delivered into the side flow pipes on either side.

The loops in which the steam is generated are divided length-wise of the boiler, and thus provide for proper expansion and contraction. The steam drum being carried half full of water, all of the pipes and connections which are exposed to the direct action of the fire are protected by water.

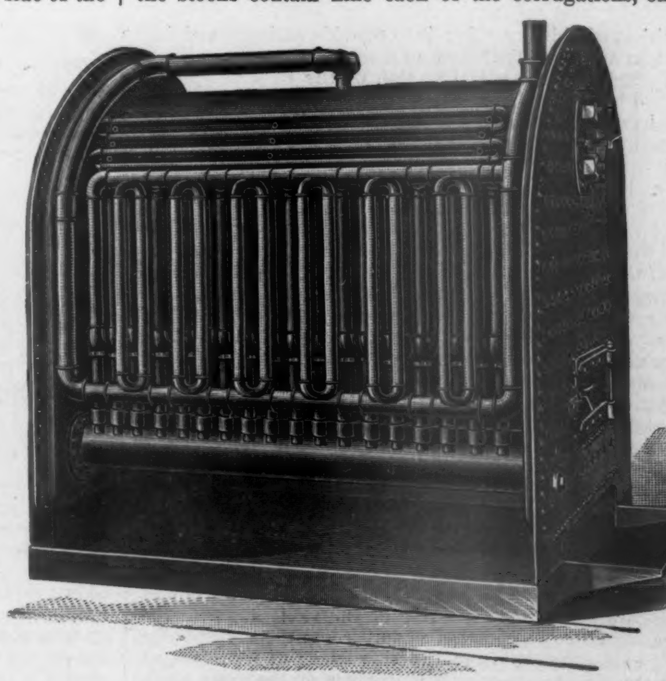


Fig. 2.

BOILER COMPLETE (WITH SIDE-CASING REMOVED) SHOWING DISPOSITION OF SUPERHEATING COILS. FROM PHOTOGRAPH OF A 50 HORSE-POWER BOILER.

A LESSON IN MILLING.

THE Pratt & Whitney Company, of Hartford, Conn., have sent us some very interesting photographs showing a "gang mill," for cutting corrugations in the surface of heavy plates and finishing the whole plate at one operation. As these illustrations have already appeared in a number of other technical papers, they are not reproduced. The one represents a view from a washed drawing showing the machine in which the milling was done, and the other is an enlarged view of the "gang mill."

Of the work done by this machine and the tool referred to, this Company say:

"An achievement in the line of surface milling which so far surpasses anything in the ordinary as to make it of special interest, is at present in progress at the works of the Pratt & Whitney Company, Hartford, Conn., and which is illustrated herewith from photographs taken of the machine in operation.

"The work consists in the corrugation of metal plates by milling, using gang mills and finishing a plate at one cut.

"These plates are of steel $\frac{3}{4}$ in. thick, 24 in. wide, and 40 in. long. The corrugations are formed of arcs of circles of $\frac{3}{16}$-in. radius, and cover a surface 20 in. wide by 33 in. long, and milled to a depth of $\frac{5}{32}$ of an inch, requiring, as will be seen, a gang of mills 33 in. in length to do the work.

"Spencer Kellogg, of Buffalo, N. Y., for whom this work is being done, uses in the manufacture of a certain product about 1,000 of these plates, and so great has been the need of them that it has been necessary to work 24 hours per day, using double sets of mills to avoid the loss of time consumed in grinding.

"The manner of making these mills will also be of interest. One set is made up of 30 separate pieces, each 8 in. in diameter, $1\frac{1}{8}$ in. wide, and 4 in. bore, the faces of each being ground so that the joint will show as little as possible on the milled surface. In the other set there are four mills only or four blocks. Two of the blocks contain nine each of the corrugations, one eight, and one seven, making the same number as the former set, and being the same dimensions otherwise. They are interlocked,

forming in effect a solid mill 33 in. in length, 8 in. diameter, and leaving a surface absolutely smooth. The cutting edge of each row of teeth in the blocks are set far enough back of the teeth in the preceding one, so that only one block or eight mills are cutting at one time.

"The plates are milled at the rate of about one an hour, including changing, and the mills being kept well lubricated, run from six to seven days without grinding.

"The machine in which these mills are operated and shown in illustration is built by the Pratt & Whitney Company, and known as No. 7 Double-Head Power Miller, and is probably the only machine built in this country capable of doing this work. It was designed and built to meet the requirements of work of this kind. It is built with either single or double-head, and provisions made for driving both heads together or separately as is necessary.

"The table is driven by a large and extra long worm-gearing with rack on under side; this worm is in halves, and is adjusted for taking up wear in threads; it has ball bearing collars on both ends for taking thrust.

"The spindle is of steel with tool steel thrust collars hardened and ground. The front bearings are 11 in. long and 5¼ in. in diameter. Greatest distance between centers, 54 in.; least distance, 14 in. Greatest height, center of spindle above table, 25 in.; least height, 4 in. The table is 20½ in. wide, and the length the limit of its travel. The speeds are so arranged as to take cutters from 4½ to 18 in. diameter.

"The present work, while not showing the result in cubic inches of stock removed per minute, as in milling side-rods and like work, is probably the severest test the machine has been put to, owing to the great length between centers and amount of surface involved.

"The work has been watched with great interest by mechanics visiting the Company's works the past month, and astonishment expressed at the ease with which the work is done, the uniform smoothness of the milled surface, and the entire freedom from any evidence of chatter which might be expected in a gang of mills of this length."

Recent Patents.

BUTMAN'S FURNACE AND MECHANICAL STOKER.

The object of this invention is to provide an improved furnace and an automatic self-feeding mechanical stoker. Fig. 1 shows a longitudinal vertical section of the furnace and apparatus. *a* indicates a suitable masonry casing of refractory material having an arch, *p*, which extends over the grate *G*. The construction of this grate is the novel feature. It is cylindrical in form, and consists of two large wheels, one of which, *e*, is shown in the engraving. These are loosely mounted on a hollow shaft, *c*, so that they can turn independently of it, and are placed at a distance apart equal to the width of the grate. The grate-bars are attached by their ends to each of the wheels.

The fuel is fed into the hopper *f*, the supply being regulated by a sliding door, *f'*. The grate is slowly revolved by gearing *s*, which is driven by a worm-wheel and pulley, *P*.

The combustion chamber *k* extends downwardly to what, in locomotive parlance, would be called the "forward" part of the grate or drum, to a point a short distance above its horizontal diameter, where it communicates with the up-take and is provided with an inclined dump-plate or tail-piece, *o*. The inner edge of this is arranged in close contact with the surface of the grate, so as to scrape all ashes and clinkers therefrom.

Below the grate an ash-pan or air-controlling box is located within the cylindrical grate or drum, and is composed of the curved bottom 2, extending from a point at a distance from one side of the grate periphery over the shaft to the inner side of the grate-bars at the opposite side of the shaft and near the discharge from the combustion chamber and the vertical side plates 2', extending up from the side edges of said bottom upwardly to the inner surfaces of the rim of the grate head, so that a complete box or conduit is formed beneath the active surface of the grate, with an opening at the front end of said box at the front side of the grate. This box is supported by arms 3 extending upwardly from and rigid with the shaft and secured to said box, so that the box can be moved or rocked within the drum by rotating or turning the shaft. The inner or closed end of said box is provided with a shoe, 4, fitted and curved to conform to the curvature of the inner surface of the periphery of the grate, so that by rocking the hollow shaft the said box can be rocked to throw said shoe forwardly and rearwardly, and thereby decrease or increase the area of the grate to which air will be supplied from said box.

In fig. 1 the full active surface of the grate is shown supplied with air, as the shoe is located below the tail-piece over which the ashes are discharged; but if the rear end of the ash box should be rocked upwardly the said shoe would move up to a point above said tail-piece, and thereby shut off a corresponding area of the grate on which fuel is located from the supply of air passing in through said ash box. By this construction the air can be concentrated on the incandescent portion of the fuel or on the green fuel. Suitable means can be employed to rock the said shaft and pan. A toothed segment, 5, rigid with the said shaft and in engagement is shown with a worm, 6, carried by the inclined shaft 7, suitably journaled and extending forwardly to the front exterior of the furnace, where it can be provided with a suitable handle, *h'*, for rotating the shaft.

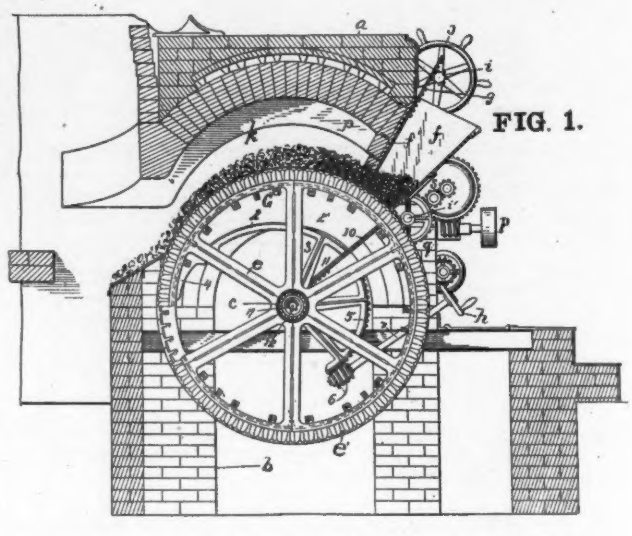


FIG. 1.

BUTMAN'S FURNACE AND MECHANICAL STOKER.

The ash box has the upwardly curving bottom, so that the area of the ash box gradually decreases rearwardly, which assists in throwing the air outwardly and upwardly through the grate-bars where the air is most needed—that is, at the point of greatest heat directly over the central portion of the drum.

The inventor says:

"The quantity of fuel consumed per hour can be readily regulated either by increasing or decreasing the speed of the grate drum; by increasing or decreasing the depth of fuel by means of raising or lowering the hopper gate; by means of the damper in regulating the admission of air to the fuel, or by placing the box in such a position as to increase or decrease the actual grate area supplied with air."

Mr. T. R. Butman, of Chicago, is the inventor. His patent is dated September 18, 1894, and numbered 526,341.

WORTHINGTON'S SECTIONAL STEAM-BOILER.

The object of this invention, shown in fig. 2, is to arrange the parts so that the furnace doors *I* may be located in the sides instead of the ends of such boilers, which arrangement will permit of the length of the boiler or the number of series of water tubes employed being increased to any reasonable limit, without in any way increasing the number of steam or water drums, the distance from the doors of the fire-box to the rear of the furnace, or the distance within which the firing or stoking of the boiler will have to be effected.

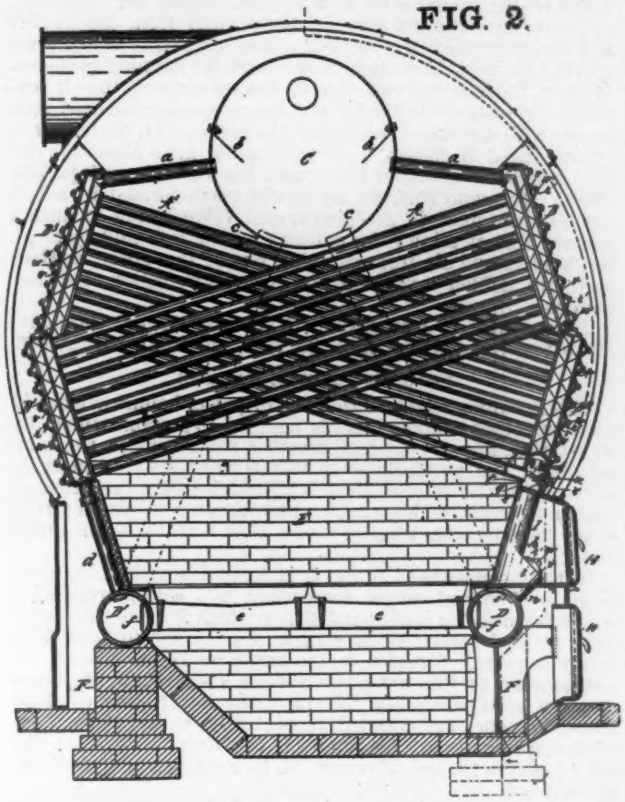
The invention is described as follows in the specifications:

"*A A'* indicate the water tubes, which, in my preferred form of construction, are arranged in series, with the individual tubes of each series disposed the one above the other, and *B B' B² B³* the water-tube headers, in which the ends of the water tubes *A A'* are respectively secured by expanding

the same in suitably shaped orifices formed therein. The series of water tubes A, with its headers $B\,B'$, are inclined to the horizon in one direction, and are alternated with the series of water tubes A', which, with its headers $B^9\,B^8$, are similarly inclined in the opposite direction. As thus disposed, the series of water tubes lie side by side in a horizontal direction, and the length of the boiler depends upon the number of series of water tubes arranged in that relation.

"Connected with the upper ends of the headers $B\,B^8$, by tubes a, is the steam and water drum C, which preferably extends throughout the entire length of the boiler, and is provided on its interior, over the ends of the tubes a, with deflectors b, by means of which the currents of water passing upward through such tubes will be deflected downward; while below the series of water tubes $A\,A'$, in positions substan-

FIG. 2.



WORTHINGTON'S SECTIONAL STEAM BOILER.

tially under their respective lower ends, and connected with the steam and water drum C, by down-flow tubes c, are water drums $D\,D'$, one of which, the drum D', for instance, is connected with the lower end of the headers B' by tubes d.

"Located under the water tubes $A\,A'$ and steam and water drum C is the fire-box or furnace E, which is provided with suitable grate-bars e, that, as here shown, are supported at their ends by the water drums $D\,D'$, which connected by pipes f, preferably extended throughout the length of the boiler are, in turn, supported by suitable masonry piers F, or otherwise."

The patentee is Mr. Amasa Worthington, of Brooklyn, N. Y., and the number of the patent is 524,877, which is dated August 21, 1894.

HANNAN'S COAL-STOKER.

The inventor of this appliance, fig. 3, describes its object in the following long sentence:

"It is to produce a tilting coal-stoker mounted in a boiler front, into which the coal is shoveled, and in which the coal is more or less coked, before it is dumped onto the fire by the tilting of the receiver, so that more or less of the smoke-producing gases are eliminated before it is ignited; in which the tilting of the receiver, at least substantially, closes the opening in the boiler front, thereby preventing the indraft of a large quantity of cold air and the damages resultant therefrom to the fire, the flues, the heads, and the other parts of the boiler; in which the receiver when restored to its normal position after dumping tightly closes the opening in the boiler front."

Its construction is further explained as follows:

"A is a boiler front, and a is a boiler of any construction. Said front is provided with an opening, above the fire and front door, in which the coal-receiver B is mounted and adapted to be tilted, consisting of a metallic plate, b, which constitutes the bottom thereof, having its front end upturned to create the front b' of said receiver. Its inner end bears against the transverse wall or baffle plate c. Its top is closed

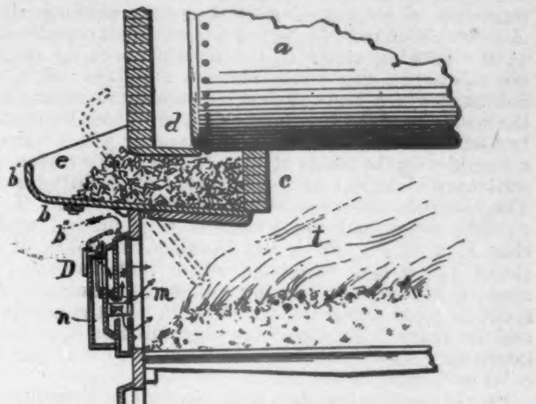


FIG. 3.

HANNAN'S COAL-STOKER.

by the plate d. The tilting bottom b rests and rocks upon the boiler front, and when tilted, as shown by the dotted lines, is supported by the lug b'' upon the bottom.

"As the tilting of the coal substantially closes its opening in the boiler front, substantially all indraft of cold air is there prevented."

William H. Hannan, of Syracuse, N. Y., is the inventor. His patent is numbered 523,982, and dated August 7, 1894.

COLE'S METALLIC ROD-PACKING.

Mr. F. J. Cole, Mechanical Engineer of the Baltimore & Ohio Railroad, has patented the very ingenious form of packing shown in fig. 4. In describing his invention, he says that it is well known that in piston and other rod-packing, in which the metallic rings are pressed against the surface of the rod by being forced into a conical or other shaped cup having a tapered form, by means of a spring acting in the direction of the axis of the rod, that the rings frequently bind so tightly on the rod, due to roughness or slight irregularities in same, or by reason of a lack of oil, or by being too tightly forced

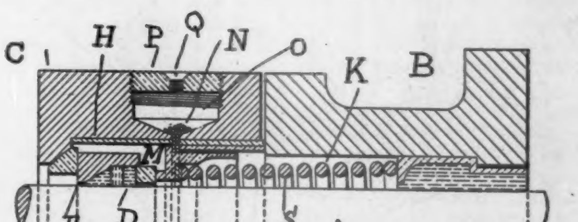


FIG. 4.

COLE'S METALLIC ROD-PACKING.

against the surface by the action of the spring, that instead of the rod sliding through them, the rings are carried back by the motion of the rod until the spring is entirely compressed, when it suddenly flies back to its original position, often causing the breakage of some of the parts, and nearly always resulting in unduly jamming the rings in the conical cup. In order to partially overcome this, it is customary to use an undue amount of spring pressure and increase its strength far in ex-

cess of what would be normally needed to keep the rings in sufficient contact with the rod to make a steam-tight joint. No provision has hitherto been made in this form of packing to automatically restrict this motion, and the object of this invention is to provide an abutment or stop which is automatically forced forward by the action of the spring, and blocked in its advanced position so that the metallic rings cannot be pushed out of position by the action of the rod.

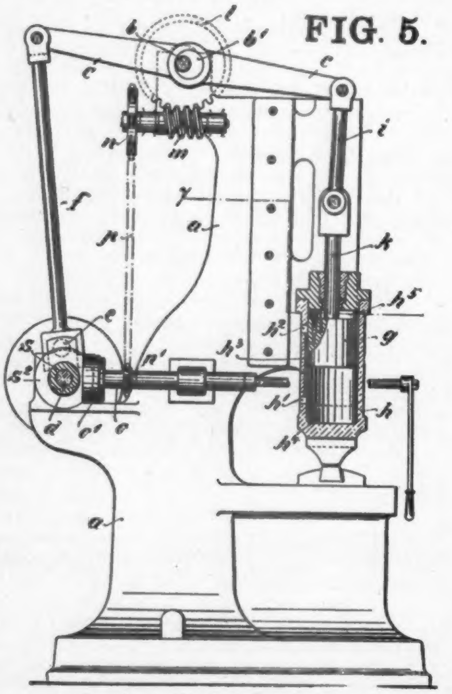
One of the methods of doing this is shown in fig. 4, which represents a section of a stuffing-box, packing rings, etc. *A* is the piston-rod ; *B*, part of a steam-chest or cylinder-head ; *C*, the packing case ; *D*, the metallic packing rings ; *E*, a conical-shaped cup which receives the rings ; *G*, a movable abutment which bears against the packing rings, and on which the spring receives the rings ; *G*, a movable abutment in contact with the ring *F*. *S* is a spiral spring which bears against a shoulder on the inside of *G*. *H* is an inside casing, and *L* a stationary abutment or sleeve which fits tightly inside of *H*. The movable abutment *G* has an outside collar, *M*. As the packing wears and the abutment *G* is pressed against the ring *F*, a little space is left between the collar *M* and the sleeve *L*. *O* is a receptacle which contains shot *N*. The space *O* has a small opening which communicates with the space between *L* and the shoulder *M*. As the packing wears and the space is increased the shot fall into it, and thus, by interposing a solid substance between *M* and *L*, prevents the axial movement of the packing rings.

In his specification Mr. Cole shows and describes several other methods of holding the packing rings in their place after they become worn, but the one described seems to be the preferable plan, and is certainly very ingenious. Mr. Cole's patent is numbered 526,381, and dated September 25, 1894. His address is Mount Clare, Baltimore, Md.

BÊCHÉ'S PNEUMATIC HAMMER.

This invention refers to pneumatic hammers, in which the hammer-head proper is formed by a heavy cylinder containing a piston, and in which this latter is employed for operating said cylinder or hammer-head ; and the improvements relate to means for altering the height of stroke of the head, and also to means for automatically replacing the air for the upper air-cushion, if the quantity of the air of this cushion has become a too small one or has entirely been displaced.

FIG. 5.



BÊCHÉ'S PNEUMATIC HAMMER.

The frame *a* of the pneumatic hammer (fig. 5) holds on its top the shaft *b* in the two bearings a' a^2. Said shaft has an eccentric, b', carrying the beam *c*. This beam may be oscillated from shaft *d* by means of a crank, *e*, and connecting-rod *f*, and transfers its motion to the piston *g* within cylinder *h* by means of the connecting-rod *i* and piston-rod *k*. In order to turn the eccentric b', or, in other words, in order to raise or lower the beam *c* by means of the said eccentric, the shaft *b* has been provided with a worm-wheel, *l*, gearing with a worm, *m*. This latter is firmly connected with a chain-wheel, *n*, and may be turned from a sleeve, *o*, by means of chain-wheel n' and chain *p*.

The left-hand end of shaft *d* carries a sleeve, *s*, with two flange-like friction disks, only one of which, s^2, is shown, the rotations of which latter may be transferred on the sleeve *o* by the broad, disk-like end-piece o' of said sleeve *o*, so that by causing contact of disk o' with one or the other of the disks s^2 the worm-wheel *l* may be turned in one or the other direction, and the beam may thus be raised or lowered, just as required for a heavier or slighter blow of the hammer-head.

The differences in the height of the hammer-head caused by another position of the eccentric b' may well be seen from the engraving.

The interior space of cylinder *h* communicates with the outer air by means of two apertures h' h^2 connected at the inside of the cylinder by a groove or channel, h^3. The said apertures are situated some distance apart from the bottom and the cover, so that spaces h^4 h^5 are formed, in which some air may be kept back and compressed for forming cushions. If, now, the hammer moves with but slow speed, the air contained in space h^5 could by and by escape, as the head then moves with the same velocity as the piston. If, thereafter, a greater speed is chosen, a vacuum would arise above the piston, which, as a matter of course, can be of very injurious effect. To avoid this, an automatic valve formed by a ball has been arranged in the piston, said valve acting in such a manner that it allows the entrance of air into said space a^5, but hinders said air from escaping out of that space, so that, therefore, neither a vacuum nor even a rarefaction of air can happen.

The inventor is Jean Bêché, of Hückweswagen, Germany. His patent is dated September 25, 1894, and numbered 526,606.

BEAUDRY'S POWER HAMMER.

This invention relates to the class of power hammers wherein a reciprocating hammer-head is coupled to a crank which, by its rotation, imparts the reciprocating movement to the hammer-head, and particularly to that type of such hammer in which an elastic intermediary is placed between the hammer-head and crank, which enables the operator to give a stroke to the hammer somewhat in excess than that due to the crank alone.

In the hammer-head 3, fig. 6, is formed a socket, 3^a, to receive a Y-shaped piece comprising two spring-arms 9, 9, which have each a half-round shank which fits into the socket 3^a, a pointed screw, 10, serving as a set-screw to hold them firmly in place. Coupled to the crank-pin is a crank-rod, 11, and secured to this rod adjustably is a sleeve, 12, on which are two spring-branches, 13, 13. The lower ends of these spring-branches are coupled, respectively, to the upper ends of the spring-arms 9 by links 14, as shown in fig. 1. The rod 11, sleeve 12, and branches 13, 13 constitute a spring connecting-rod.

It is desirable where the hammer is to operate on pieces varying considerably in thickness to provide a means for varying the distance between the center of the crank-shaft and the lower face of the hammer-head, and this may be done by adjusting the shanks of the spring-arms 9 in the socket in the hammer-head, or by the adjustment of the sleeve 12 along the rod 11, securing the sleeve in place by means of a pointed set-screw, 15, which is driven into a longitudinal slit in the crank-rod so as to expand the latter in the sleeve and hold it fast therein.

When the crank-shaft rotates slowly the hammer-head will have given to it a stroke or travel about equal to the throw of the crank, but if set in rapid motion the momentum of the hammer-head acting through the spring-arms 9, the spring-branches 13, and links 14, will impart to the head a greater length of stroke, the spring connecting media being distensible longitudinally. The device will also serve to overcome gradually the inertia of the hammer-head at the ends of the strokes. The tension of the spring-arms and spring-rods may be increased by means of a tension-regulating screw, 16, which passes freely through one branch 13, and screws into the other, as clearly shown.

The inventor is Augustin Beaudry, of Somerville, Mass.; the number of patent is 526,370, which is dated September 25, 1894.

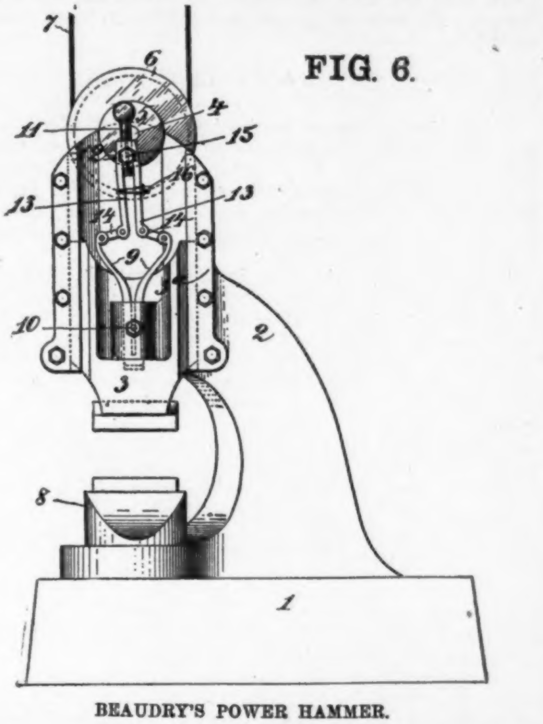
WARREN'S SHIFTING LINK.

Mr. William B. Warren, of Peoria, Ill., has patented the novel arrangement of link shown in fig. 7, which he describes as follows :

"My invention resides in the manner in which the outer ends of the eccentric rods are connected to the skeleton link, with relation to the saddle-pin 15, whereby a more perfect working of the parts is attained. To accomplish this object,

I first establish a center line, *A*, from which lines *B*, *B*, *C*, *C* and *D*, *D* are laid off perpendicular and at right angles to the center line, and these lines are equidistant apart on the center line. I then mark off lines *E*, *E* and *F*, *F* parallel with the center line and equal distances from the center line. I next locate the center *a* of the saddle-pin (which is the center of suspension and axis for link), where the center line and the center arc line *G*, *G* intersect with the center line *C*, *C*. I then locate the coupling-pin hole 10 at the intersection of the lines *E*, *E* and *D*, *D*, and locate the coupling-pin hole 11 at the intersection of the lines *B*, *B* and *F*, *F*, and I thus have the coupling-pin holes located at different distances from the main shaft and each located on a different side of the center arc *G*, *G*, and they are located at equal distances in a perpendicular measurement from the center of the saddle-pin 15, and are likewise located at equal distances in a horizontal measurement from the center of the saddle-pin, thereby forming a straight line, *H*, *H*, through the center of the saddle-pin, the coupling-pin hole 10, and the coupling-pin hole 11, so that the point of connection between the eccentric rods with the link 9 each travel an equal distance to or from the central line of motion at a movement of the link either along the center line

FIG. 6.



BEAUDRY'S POWER HAMMER.

of motion or rotation on its center of saddle-pin. I thus equalize and proportion to better advantage the angularity of the eccentric rods, thereby producing more correct and equal cut-off and exhaust of the openings in the main valve at all points of the stroke of the engine, and this is done without sacrificing the lead or admission openings of the main valve. By this arrangement also I am better able to locate the center of the saddle-pin on the center arc *G*, *G* of the link 9, thus reducing the slip of the link on its block, and reducing the strain and wear of all parts of the link-motion and doing away with the customary way of equalizing the main valve cut-off, and exhaust openings, which was done by locating the center of saddle-pin back of the center of arc *G*, *G*, and link, which caused slipping of the link on the block 12, resulting in wear and strain on the link-motion. These advantages are attained without complication, or without the use of more parts than usually employed in link-motions, and the improvement can be applied to all shifting link-motions in use, and at a small cost."

We will suggest to some of the younger engineers or draftsmen that an investigation, either on a model or diagram, of the merits of this design for a link would be interesting. It is not at all obvious that it possesses the advantages claimed for it. The patent is numbered 521,398, and dated June 12, 1894.

GÖLSDORF'S COMPOUND LOCOMOTIVE.

The patent for this invention, which is being introduced into this country by the Nathan Manufacturing Company, of New York, has recently been issued. It is, or should be, of so much interest to locomotive engineers that we give the description in full, which is published in the patent. The inventor describes his invention as follows:

"Hitherto it has been necessary, for the purpose of enabling compound locomotive engines to be started in whatever position the crank of the high-pressure cylinder may be at the time, to provide in the pipe or passage connecting the high-pressure cylinder with the receiver special closing or cut-off devices, such as cocks, valves, or dampers, that are operated, at the moment when the engine is to be started, in such a manner as to prevent the fresh steam supplied from the boiler and entering the receiver and low-pressure cylinder from exercising an injurious counter-pressure in the high-pressure cylinder on the side opposite to that in which the high-pressure piston moves when the distributing valve of such cylinder is closed.

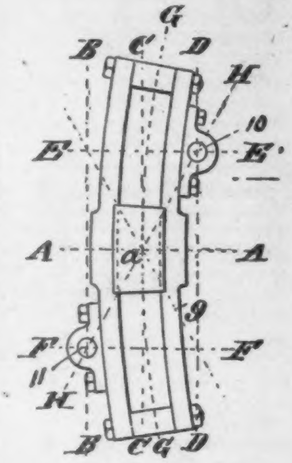
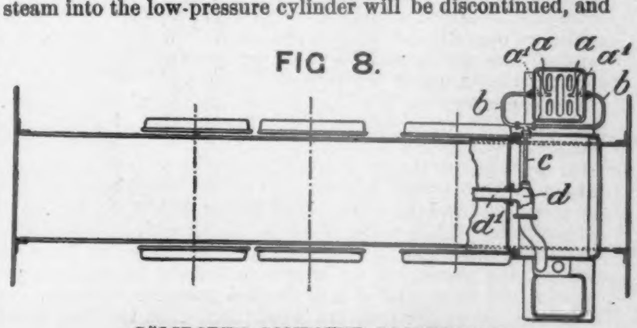


FIG. 7.

WARREN'S SHIFTING LINK.

"This invention has for its object to enable compound locomotive engines to be started without the employment of any special devices such as referred to, however unfavorable the position of the cranks may be at the moment; as, for example, when the crank of the high-pressure piston is nearly horizontal and that of the low-pressure piston is practically vertical. For this purpose the valve face of the low-pressure cylinder is formed with orifices or ports that are in communication with the main steam-pipe or boiler, and are so arranged that during the ordinary operation of the engine they will be effectually closed, while when the engine is to be started, in which case the ordinary working point of cut-off (corresponding to form about 50 to 60 per cent. of the piston stroke) is exceeded, one of these ports will be uncovered or opened whereby steam will be admitted to that end of the low-pressure cylinder corresponding to the required direction of motion, with the result that the low-pressure piston will be set in operation. From the steam-chest of the low-pressure cylinder the live steam passes into the receiver, and thence into the high-pressure cylinder entering on that side of the piston therein, which is opposite to that in which the movement of the piston ought to take place. Thus the steam entering the high-pressure cylinder will exercise a certain counter-pressure, which, however, will be overcome by live steam from the boiler as soon as the position of the cranks undergoes the slightest alteration, such live steam from the boiler entering direct into the high-pressure cylinder. When the low-pressure slide-valve assumes such a position that the port, which until then has been open, is closed, the direct admission of steam into the low-pressure cylinder will be discontinued, and

FIG 8.



GÖLSDORF'S COMPOUND LOCOMOTIVE.

therefore any injurious counter-pressure that might otherwise result therefrom is completely obviated, so that the locomotive engine can then be started by the steam pressure exerted upon the high-pressure piston alone. This arrangement is applicable to compound engines with two or more cylinders, and may be used in conjunction with any form of link motion for the purpose of starting engines, provision being made for all the conditions on which the point of cut-off depends (such as the extent of motion of the eccentric, the effective length of the link, the angle of lead, etc.) to be fulfilled as to allow of a maximum point of cut-off (corresponding, say, to about 90 per cent. of the stroke of the engine).

"In order that the invention may be fully understood, reference is had to the accompanying drawings, in which fig. 8, a horizontal section, and fig. 9, a vertical cross-section of a compound locomotive engine, constructed in accordance with this invention. Fig. 10 is a plan to a larger scale, of the slide-

FIG. 9.

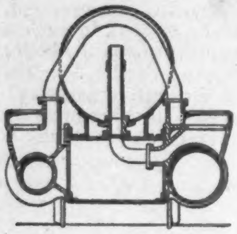


FIG. 10.

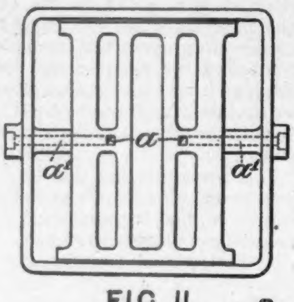


FIG. 12.

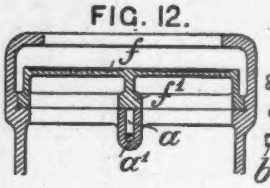


FIG. 11.

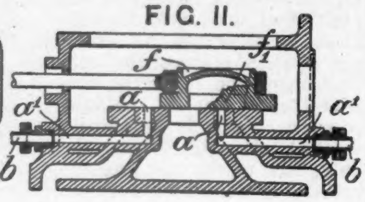
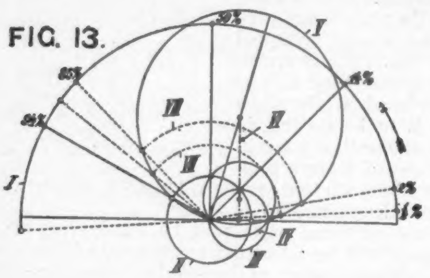


FIG. 13.



GÖLSDORF'S COMPOUND LOCOMOTIVE.

valve face of the low-pressure cylinder; and figs. 11 and 12 are respectively a longitudinal and transverse section of the valve-chest of the low-pressure cylinder. Fig. 13 is a diagram (on the Zeuner system) for a link-motion arranged in accordance with this invention.

"From the drawings it will be seen that the slide-valve face of the low-pressure cylinder is provided with two orifices or ports *a a*, that are connected by channels *a' a'* and pipes *b b* to a common pipe, *c*, that is in communication with a cross-pipe, *d*, and the main steam-pipe *d'*. The ports *a* of the said channels, *a'* are so arranged in the valve surface that in the ordinary operation of the engines, during which the point of cut-off does not exceed 50 or 60 per cent. of the stroke, they remain closed under the action of the piece or bridge *f'* of the slide-valve *f* for the low-pressure cylinder. When, however, the link arrangement is, for the purpose of starting the engine, adjusted for a larger point of cut-off (corresponding, say, to 90 per cent. or more of the stroke of the engine), one of the said ports will be opened (fig. 11) whereby steam will be admitted from the cross-pipe *d* to that end of the low-pressure cylinder which corresponds to the direction of motion of the piston at the time. When the ports are closed by the slide-valve *f*, the steam can no longer pass from the main steam-pipe *d'* and cross-pipe *d* into the low-pressure cylinder, and therefore no counter-pressure is produced upon the high-pressure piston. As, moreover, owing to the large point of cut-off, the position of the cranks is now the most favorable one, and inasmuch as the port *a*, which has remained closed up to this time, only opens when the piston stroke in the low-pressure cylinder changes, the link-motion may be absolutely relied upon for effective operation in starting the engine.

"The ports *a a* may be located at any other proper point in the face of the valve-seat, and in such relation to the valve as to be controlled thereby, and opened whenever the normal point of cut-off is exceeded, as above explained.

"The diagram of Zeuner, fig. 13, corresponds to a link arrangement fitted for a maximum cut-off (say, 94 per cent.) in accordance with this invention.

"In the diagram, I is the crank circle; II is the circle the radius of which equals the maximum overlapping; III is the slide-valve circle calculated for the minimum cut-off (14 per cent.); IV is the slide-valve circle for the medium cut-off (50 per cent); V is the slide-valve circle for the maximum cut-off; and VI is the line connecting all the slide-valve circles (the central curve).

"The distance between the two arcs of circles VII and VIII, drawn in dotted lines, equals the width of the ports *a* in the direction of motion of the slide-valve *f*.

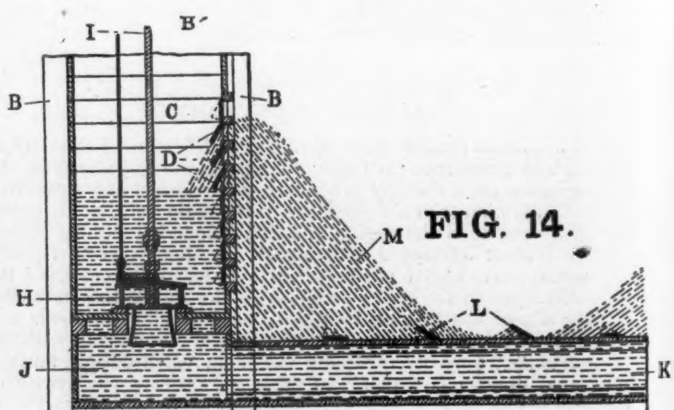
"It will be seen from the diagram that the ports *a* in the ordinary operation of the engine remain closed until a cut-off corresponding to about 50 per cent. of the stroke of the engin (which is the maximum under ordinary circumstances) is attained. When, however, the mechanism is adjusted for a cut-off corresponding to 94 per cent. of the stroke, one of the ports *a* will begin to open when the piston has completed about ½ per cent. of its stroke, and will be fully open when 2 per cent. of the piston stroke has been made. It then remains fully open until the piston makes about 85 per cent. of its stroke, after which the closing of the said port will begin. When the piston has made about 90 per cent. of its stroke the port will be completely closed again."

Mr. Karl Gölsdorf, of Vienna, Austria-Hungary, is the inventor. His patent is numbered 526,778, and dated October 2, 1894.

MERRITT'S WAVE MOTOR.

It has always been a mechanical mystery why the great power of the waves in large bodies of water has not been utilized more than it is. Mr. Charles A. Merritt, of Birmingham, Ala., has patented the contrivance shown in fig. 14, and of which he gives the following general description, from which and the engravings the construction will be understood without going into further detail:

"My invention relates to improvements in that class of wave motors in which the water from the top of a wave is stored at the highest point of the wave as a head to operate a turbine wheel, and the objects of my improvements are, first, to provide a penstock or storage reservoir to be constructed in or adjoining a wharf to receive the water from the tops of the waves, the penstock having free ingress for the water through a series of valves, the valves closing on the inside to retain the water when admitted; second, to provide a penstock of the above description with a turbine wheel to use as a motive power by which machinery can be driven on the wharf or top of the penstock for hoisting and other purposes required in the vicinity of wharves; third, to provide a tail race from the wheel for the escape of the water, the race in-



MERRITT'S WAVE MOTOR.

closed and extending at a right angle from the penstock, and having a series of valves placed on the top side of the race opening outwardly to permit the water to escape and prevent an inflow of water from the outside. I attain these objects by the construction and arrangement of the device illustrated."

NOTE.—Copies of any of the patents referred to above, or of any others in print, will be sent to any address on receipt of twenty-five cents in United States postage-stamps (not foreign stamps).

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

WHY IS ARTIFICIAL FLIGHT SO DIFFICULT OF INVENTION?

By OTTO LILIENTHAL.*

IT is indeed difficult for man to flit through the realm of air with the freedom of a bird; but the longing to do so will allow us no rest. A single large bird circling over our head will renew in us the wish to soar like it in the firmament.

The mechanical instinct of even the average man is sufficient to perceive that we need but to find the right key to unlock for our use an entirely new portal of world-wide communication. Do we not see with what calm, with what complete assurance and wonderfully simple manœuvres yonder bird is gliding through the air? Can it be that man will never be able to accomplish as much?—man, with all his boasted intelligence and with all the mechanical aids that have enabled him to build truly marvellous works! And still it is difficult—I may say exceedingly difficult—to repeat even approximately what nature performs so easily. How many vain efforts have been made to imitate the bird! This, too, now that science has seriously taken up this question; that the phenomena of natural flight have been dissected, anatomically and mechanically, optically and by instantaneous photographs, as well as graphically by electric records. Now, at last, we have progressed so far that the bird cannot mislead us as to the theory, but in practice "he has the laugh on us." As soon as we try to utilize our dearly bought wisdom in actual flight, our lack of skill is painfully displayed; the swallows fly around our heads and twitter their derision. There is probably no other branch of engineering in which it is so difficult to find the right application of our theories in actual practice.

To-day we know very well what supports the flying bird; his wing cleaves the air at great speed, and by the slender curve of its profile compels the necessary sustaining reaction, even in this thin medium. The wind which passes under the widespread sail-surfaces of the bird undergoes a gentle deviation on the concave lower surface of the wing, which results in a sufficient "lift" when the wind is strong enough. The beating of the wing complements what the sail action alone does not accomplish.

To the untrained observer, it is true, when he sees the bird in flight, the movements of the wings seem to be simple up-and-down motions; but the aviator combines the wing beats with the effect of the velocity of flight and the movement of the air, and concludes that even in rowing flight, especially for the larger birds, the carrying surfaces cut the air at a very acute angle, and that in rapid forward flight even a gentle depression of the wings produces much carrying power with little expenditure of energy.

This, therefore, is the action to imitate, this rapid forward motion, with slow beating of the wing—at least, this is what nature teaches us; but it is only in case that the process is carried on with absolute correctness that we may hope to fly in this way. If anything be omitted or incorrectly done, the whole undertaking will fail.

Whether this direct imitation of natural flight is one way out of many which will lead us to the goal, or whether it is the only way, is to-day still a mooted question; many aviators, for instance, consider the wing motion of birds too difficult to imitate mechanically, and they dislike giving up for aerial propulsion the screw propeller, which has been found so useful in the water. On one point, however, they are agreed, and that is that we must fly at high speed if we are to fly at all, and this requirement is a dangerful difficulty in the invention of artificial flight.

Fig. 1.

It is universally admitted to-day that man will not be able to rise vertically in calm air from a position of rest; no more can the large birds do so, because the expenditure of energy must be enormous. Designers of flying machines, for this reason, now arrange their apparatus so as to begin to rise with a considerable horizontal motion.

Although most projects of the kind are based upon the principle of bird-flight—*i.e.*, the supporting power is obtained by sail-surfaces rapidly moved forward—still the methods of reproducing natural flight by mechanical means are as various as the aviators who undertake the experiments, each man going his own way; but all these separate ways yet lead to one and the same reef, on which the conception and often the ingenious vessel itself is wrecked before it can be utilized for the intended purposes. Indeed they rarely, without breaking the machine, get beyond the first trial, which usually results in the failure to rise into the air at all, or at best to get back to the earth very quickly.

What it means to be whizzing through the air with the velocity of an express train, and then to come back to the ground without danger and without breaking the apparatus, it is not difficult to conceive. If this trick is to be done with a large, heavy, and complicated machine, the prospect of alighting

* Translated from *Prometheus*, No. 261, Berlin.

safely is, of course, much less. It seems really preposterous to count on success in the first trials with such complicated machinery; for this reason the reviewer in No. 259 of *Prometheus* is quite right in his statement that, by experimenting with large machines, the expense of the tuition, which we must surely pay before we learn how to fly, is uselessly increased. Maxim's flying machine, the one alluded to in the above-mentioned review, has cost a very large sum of money, and this distinguished inventor deserves high praise for having devoted so much to aviation, the hitherto Cinderella of engineering science; but, after all, the result of his labors has only been to show us "how not to do it."

This celebrated example may suffice to demonstrate that the most ingenious machinery, even when combined with powerful and very light motors, will not alone solve this intricate problem. Maxim's experiments also prove the truth of another view, which I have alluded to at every opportunity: that, in point of fact, the real destroyer of this machine, weighing 8,000 lbs., was a gentle wind gust, which, in consequence of the enormously large wind surfaces, produced a very great force. The machine could not fail coming to grief, and it will invariably come to grief whenever it is used even in a moderate wind.

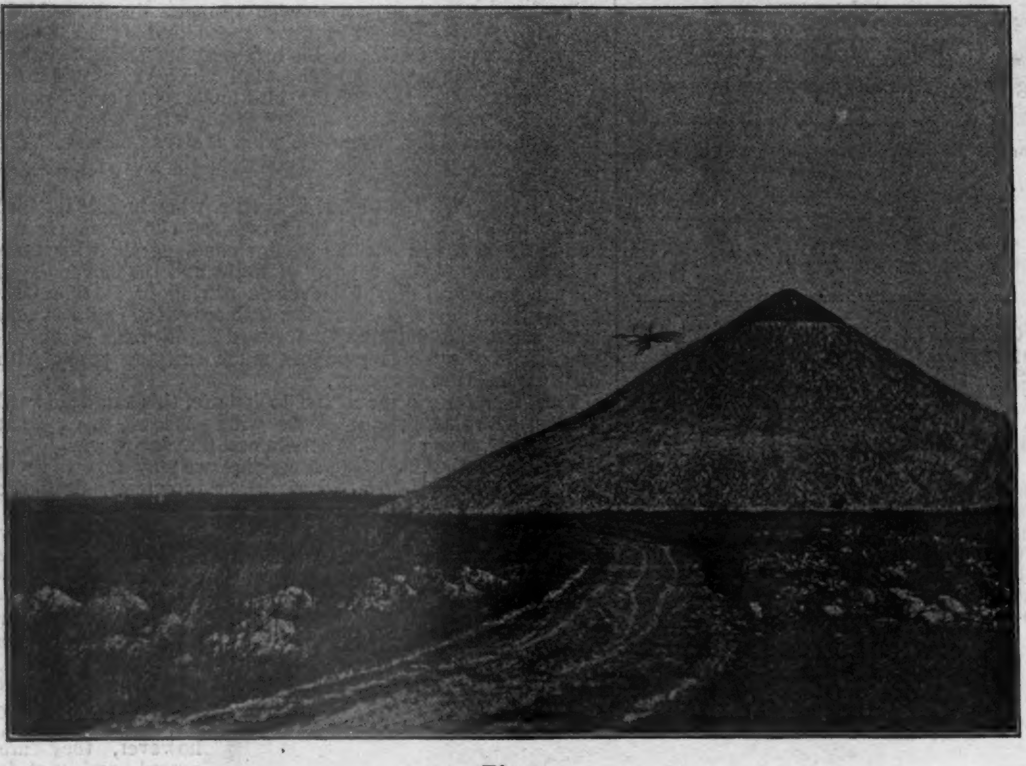


Fig. 2.

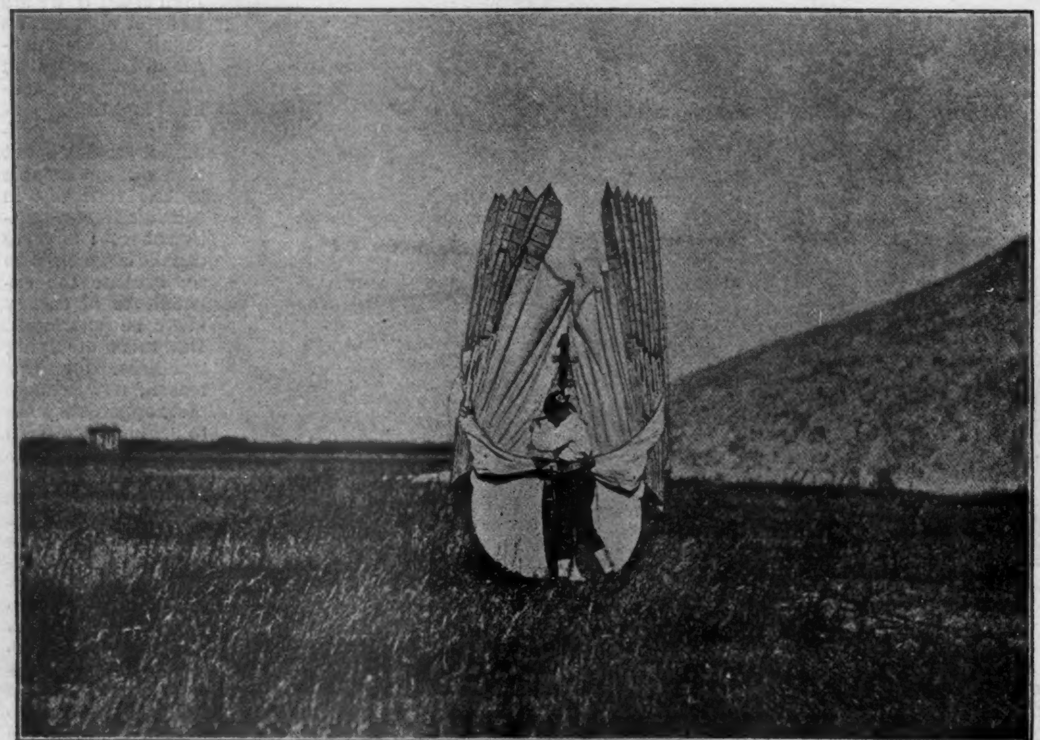


Fig. 3.

Now, which one of all the inventors of such apparatus has the proper conception of the mercilessness of the wind toward all flying machines? This brings up a new difficulty in the invention of artificial flight. I myself have often enough been the plaything of the wind, when I was taken unawares during my experiments by wind gusts; suddenly I was raised the height of a house and tossed back and forth, so that I was breathless until I got used to the sensation. In such experiments one cannot fail to become an air-gymnast in the boldest sense of the word, and I may therefore be permitted to express my opinions on the action of the wind on aeroplanes, and on the best way of counteracting its destructive force.

Herr *Anschütz*, on September 14th of this year (1894), availed himself of an opportunity of taking some photographs of my exercises in windy weather. The illustrations, figs. 5 and 6, reproduced from his instantaneous views, show what gymnastic feats are necessary to keep from being thrown from the saddle in such a squally ride through the air, and to bring back, furthermore, the flying outfit safely to mother earth. These factors cannot possibly be neglected by any one who tries to direct an aerial vehicle through moving air.

If we could not convince ourselves daily how easily and safely birds dart about in the air and command the wind, we might really despair of the invention of artificial flight. But is there any real prospect that we will attain to their skill? What are the real ultimate aims of aviation? To what degree of perfection will it ever be possible to develop human flight? Yes to *develop*, for that is the correct expression, and development is the correct line of thought, by following which we may achieve success in aviation.

No one can foresee to-day how far man will be able to educate himself in flying, because hitherto much too little work has been done in actual practice. Even though, here and there, some scheme may have been actually carried out, and then wrecked on the above-mentioned rock, yet this means very little for the development of dynamic flight. As to the rest, there is a good deal of theorizing, which also does very little good in the present state of the art.

As far as the theory of flight is concerned, we are to-day not at all badly off. Since we have been enlightened as to the air resistance under the bird's wing and the property of its curved section in economizing energy, we can explain quite clearly all the phenomena of natural flight. What we must now begin to develop *ab initio* is actual practice in flight. The difficulties that confront us now are of a purely practical nature, but they are greater than they seem to be at first blush. We must make a special study of these practical difficulties, we must devise methods of investigating them thoroughly in order to counteract them successfully. Only in this way will we be able to sow the right seed in this now unproducing field.

No matter how primitively it may begin, the method which may lead us to real flight must be capable of development. For this reason the experiments which we make must give us an opportunity of actually flying through the air, even if it be to a limited extent. In this way we will gather experience as to stability in flight, as to the action of the wind, and as to safe alighting: and thus, by constant improvement, gradually come closer to continued flight.

This consummation cannot be violently brought about. It is just because the inventors of flying machines usually expect too great immediate results from their apparatus that the actual achievements are so small. The remaining in the air without a balloon, and cruising about through the atmosphere, is a field of work so novel that we will find our bearings therein only by degrees. Whoever neglects the idea of a healthy development of the science by constantly increasing our experience on the stability and safety of movement in the air, will never accomplish anything in this field.

The methods which I have proposed and practised, in order that, beginning with short flights, I might extend my journeys to greater distances, are known to the readers of *Prometheus*,* from my articles in No. 205 and No. 220 of this journal. I will, therefore, only mention briefly at present my further experiments.

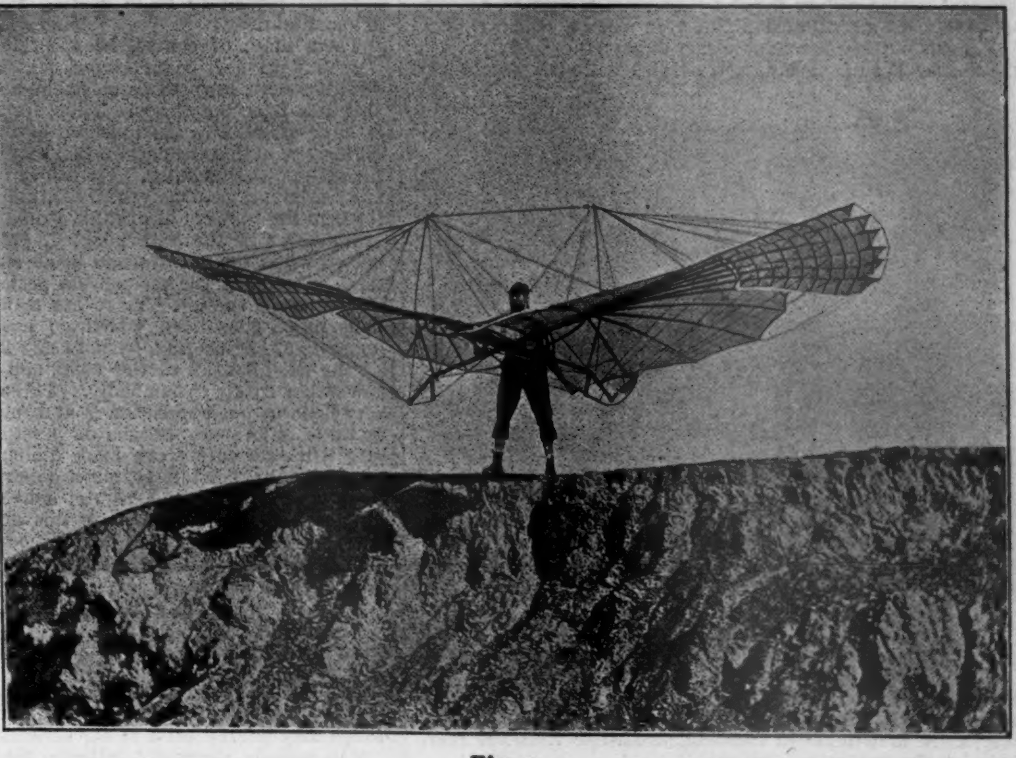


Fig. 4.

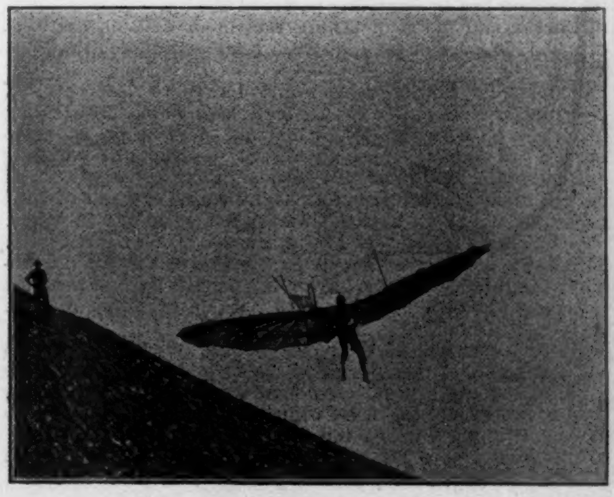


Fig. 5.

Fig. 6.

* A German paper in which the original of this article was published.

After I had definitely ascertained by my trials that gliding flight is feasible from elevated points, with quite a simple apparatus and in moderate winds, there were two further problems to be attacked. In the first place, this sailing exercise must be extended to stronger winds, so as, if possible, to reach the continued soaring which we so greatly admire in birds; and, in the second place, we must endeavor to complement simple sailing flight by dynamic means, so as gradually to reach a continued flight, even when the air is calmer.

For this purpose it was necessary to have a proper flying-off point near Berlin. I have now constructed such a point, by

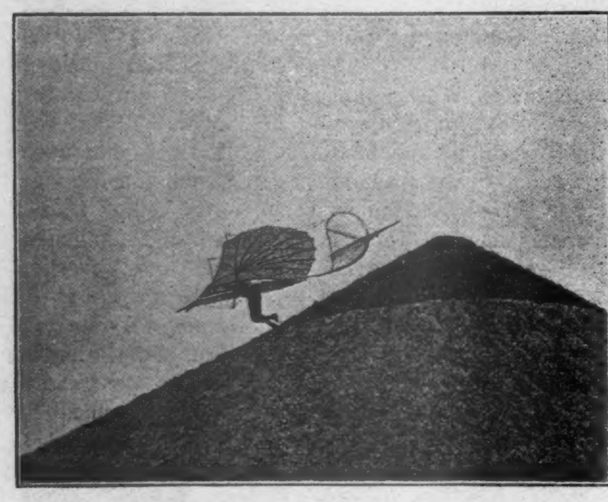


Fig. 7.

building an artificial conical hill, 50 ft. in height, in Gross-Lichterfelde, to the east of the Anhalt Railway. The shape of this hill, and the manner in which it is used, are shown in figs. 1 and 2. Under the top of the hill, which is sodded over, there is a timbered chamber, accessible from the rear, in which the apparatus is stored.

As shown in fig. 7, a run is taken to the edge of the sodding in performing the exercises. Fig. 8 shows the instant of landing, when the sail-surfaces are tipped up to the front, in order to check the velocity of the flight.

An apparatus with an attachment arranged for rowing flight has also been actually tested. Figs. 3 and 4 show this apparatus both when folded and when spread out to its full extent.

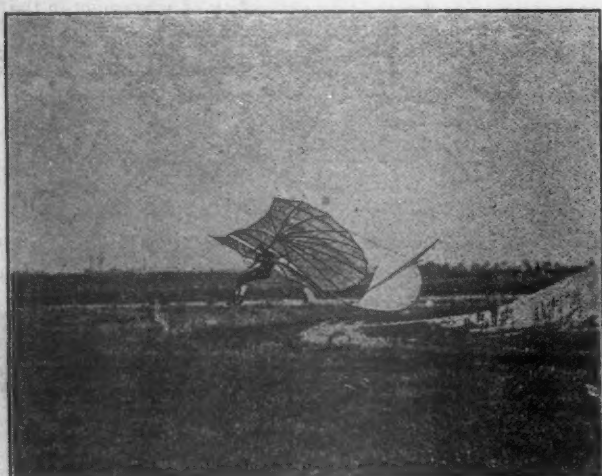


Fig. 8

The distance between wing-tips is 26 ft. 3 in. The flapping motion of the wings is produced by a motor driven by compressed carbonic acid gas. Except for the addition of the rowing device, this apparatus is built quite like my former apparatus. A pressure with a finger starts the flapping of the wings, and as to the rest, the handling of this apparatus is the same as that of the simpler form. Nevertheless, my first cautious trials proved to me that if I had thrown myself into the air with flapping wings, without further precautions, the machine would probably have reached the bottom in the condition of a wreck. There are always new, unexpected features, and a single disastrous landing will ruin the whole machine. Here, again, we are reminded that we must not make too great demands upon the machine at first. I had, therefore, to content myself at first with using this larger and heavier machine, which weighs 88 lbs., or twice as much as my simple sailing outfit, for initial plain gliding. Thus I first practised alighting safely, and now, after getting thus far, I permit myself to begin beating the wings cautiously in actual flight.

There may, of course, be other lines in which artificial human flight may be developed logically. Similar problems will, however, have to be solved in any case before this difficult task is accomplished. Thus, for instance, much energy is being devoted to the question of regulating the flight *mechanically*, so that the equilibrium may not be dependent upon the skill of the operator. We can only hope that this important, although extremely difficult, undertaking may succeed, for then the problem of aviation would be much simplified.

Whatever be the path adopted, progress can only be expected when the experiments made admit of useful observations concerning the phenomena pertaining to a body flying free through the air. There are many entirely new conditions to be considered which do not confront us in other branches of engineering, such as safe and stable flight against all the irregularities of the wind, and the alighting without risk when flying dynamically. These are points on which very little actual experience is at hand, and yet these will be found to be the very essence of practical aviation. This feature will assuredly make more difficult the solution of the problem of artificial flight, but it does not by any means make it impossible. As soon as the conviction becomes general that investigation is needed in this direction, the force now scattered in all directions will become concentrated at the right point, and thus perform efficient service in steadily developing free flight.

MAKING BALLOONS.

A CORRESPONDENT of the *English Mechanic* gives the following description of the process of manufacture of balloons, which may interest some of our aeronautical readers:

"In making passenger balloons, the silk is, first of all, cut into strips and sewn together. The globe form is then partially filled with air and varnished several times; also tested with air inside and a covering of water outside. If the silk is leaky, bubbles appear in the water. A valve is fitted to the top of the balloon to allow the gas to escape. The valve rope passes right through the center of the balloon to the car beneath. Strong network encompasses the silk when it is filled, and is attached to a hoop, from which the car is suspended. Coal gas lifts 40 lbs. per 1,000 cub. ft.; hydrogen gas lifts 70 lbs. per 1,000 cub. ft. The smallest balloon for passengers is the 12,000 cub. ft. Its weight complete is 280 lbs., and the gas will lift 12 times 40 lbs. = 480 lbs., so that when inflated the balloon has an ascending power of 280 lbs., equal to a man of 150 lbs. and 50 lbs. of sand. Weight of balloon, 280 lbs.; of man, 150 lbs.; of sand, 50 lbs.; total weight, 480 lbs."

Hargrave's Experiments.—Mr. Lawrence Hargrave, of New South Wales, after having built some 18 models of flying machines, all of which fly, is understood to be preparing to build a full-sized apparatus capable of sustaining his weight.

He has lately experimented with a gliding apparatus, based on the same general principle as Lilienthal's, but provided with four wings set at a diedral angle instead of two wings. The bearing surface was 150 sq. ft., and the weight 25 lbs. This did not prove a success; the machine was flabby and unhandy, and turned over with the operator, who then resumed his labors upon his "cellular kites," which were illustrated in AERONAUTICS.

He now has one of these which flies to windward of its starting-point. Upon the string being tied to a stake in the ground, and the kite raised, it first ascends a certain height, then advances into the wind while the string blows back into a deep *bight*, upon which the kite descends, and comes down to the ground at a point between the stake and the original point of raising, thus performing a feat somewhat like "aspiration."

The construction of the cellular kite has also been simplified, so that it can be readily folded and carried about when of large size.

The last advices from Mr. Hargrave were dated September 23, 1894, which is about the opening of spring in the southern hemisphere, so that we may expect to hear of interesting experiments tried by him during the coming Australian summer.